Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

A Monthly Record of Science.

Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

FEBRUARY, 1911.

APPARATUS FOR PHOTOGRAPHING NATURAL HISTORY OBJECTS.

By W. FOTHERINGHAM.

COLLECT, examine and record, is probably a good summary of the work of the average Nature student.

He has not gone far in his work when he finds that to properly examine all he collects he requires a microscope, and that to record his finds in the easiest and most truthful way, he must have a camera. Now the enthusiast will soon find himself in difficulties about apparatus, especially apparatus for recording his facts, either for future comparison or for the benefit of others. What ought to be a pleasure, the making of an interesting, perhaps pretty, picture of his facts, is, owing to faulty apparatus, a disagreeable task, costly in time and uncertain in results. So for every ten who are skilled in the first two parts of the work there is probably not one in the third. To carry out this programme let us see what is needed. Supposing the collecting and examining be "taken as read," he requires:—

(1) A Field Camera. If this is of the "hand or stand" type, it will "cover a multitude" of things.

With it he may, with some circumlocution, even take at home, with pains, indifferently good pictures of "birds, beasts and reptiles."

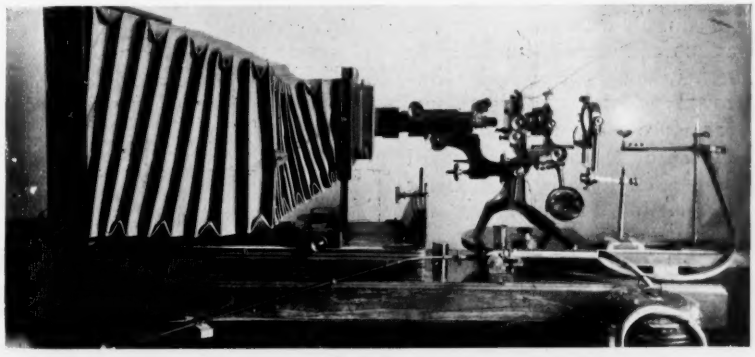

FIGURE 1.

A 15×12 Photomicrographic Camera.

With wooden optical bench, Watson "Van Heurck" microscope, Nelson Condenser, and acetylene jet on sliding wooden feet, permitting right angle centring adjustments.

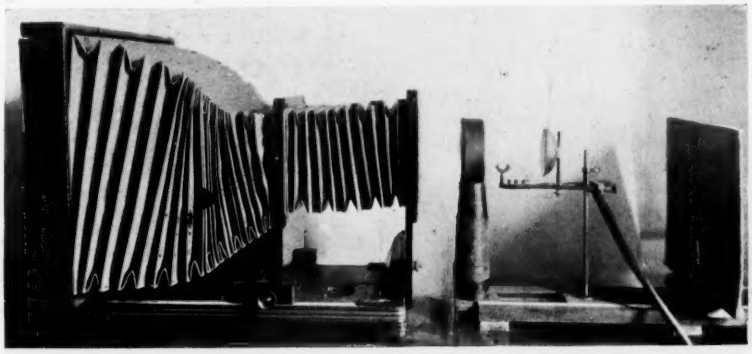

FIGURE 2.

The Camera used for enlarging or reducing.

With improvised condenser and jet on optical bench. Also a supplementary board, on which objects may be pinned out when the apparatus is used as ordinary or copying camera.

Ultimately he will probably get a bigger camera on legs, that behave themselves better on a floor than do those of the ordinary field tripod.

Even then he will be annoyed to find that he cannot take a picture of many things, in spite of much pinning-out and arranging on board or wall, and that such things as eggs have an ugly shadow round them, while fragile dissections are out of the question, as is any preparation floating in fluid. He will probably long for a vertical arrangement that will enable objects to be

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laid beneath the camera, and yet be properly illuminated either by transmitted or incident light.

(2) To get photographs of minute objects through the microscope, he probably has the usual horizontal photomicrographic camera, and nothing can be better for mounted objects; but the biologist, as distinct from the photographer, wants to preserve the record of objects as they appear when fresh, and not formalined or dehydrated and beautifully "squashed" on neat slides.

So here also he wants a vertical apparatus to take such objects as cannot be pinned up.

(3) To complete his work he probably also has an enlarger, and an arrangement for making lantern slides.

Now, with a full knowledge of practically all that is offered by both English and Continental makers, I am yet of opinion that there is no handy apparatus that will do all this, and that the various equipments now on the market, although vastly improved within the past five years, are still unsatisfactory.

Most of them are too small and incomplete, being without stability, adaptability, and rigidity, and without optical bench, which means *sans* everything that is essential.

Writing some time ago to the maker of a new photomicrographic camera, I pointed out that this camera failed to meet my needs and gave details of objects I wanted to photograph. He replied: "We prefer to use separate apparatus for such work."

Exactly! So have I in days past; and the result has been: two ordinary cameras, two photomicrographic cameras, a bulky enlarging and reducing camera, and a host of fakes and fitments in the shape of easels, backgrounds, glass platforms, and so on—a lot of dusty, unready apparatus that lumbers one's working space and would require one's whole time to keep in order.

How often after a clean up have I said: "I wish they could all be rolled into one" and one day—happy thought! —I said, "I will roll them all into one," and almost literally did so.

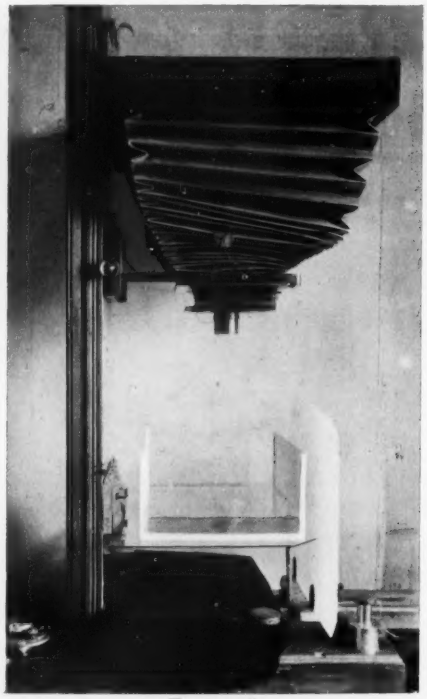

FIGURE 3.

Camera raised to vertical position on hinges. It is secured by two T bolts with Bausch and Lomb "Y" dissecting microscope, Nelson condenser and jet.

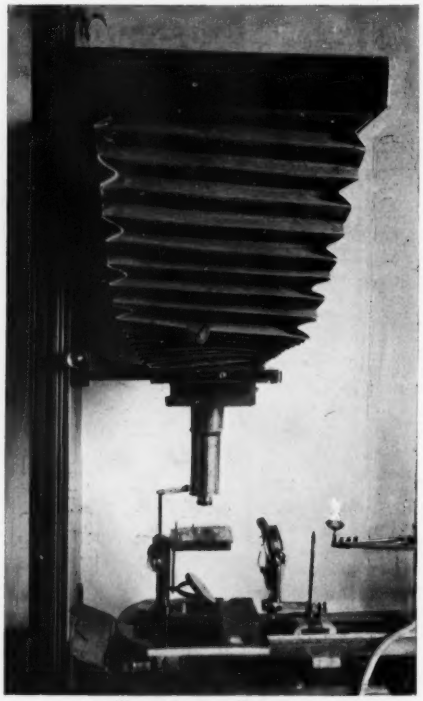

FIGURE 4. Camera.

With sliding glass platform on which is glass tank. An optical bench support with large sheet of ground glass, prevents reflections from the water.

The result is a camera, suited for practically every need of the biologist, more easy of manipulation, and withal a lot cheaper than anything I can find elsewhere.

Being composed mostly of parts of other apparatus, as I am no tradesman, it may appear a bulky collection of odds and ends, but it is at least as compact as any other one photomicrographic camera, and more useful than any other two, covering with great ease an enormous range of work.

The idea, however roughly carried out, is sound, for both English and Continental makers have been groping their way to this type for some years.

Unquestionably this type is the apparatus of the future in all but the largest laboratories, where space and expense do not require consideration.

In Figure 1, it is shown as the usual horizontal photomicrographic camera, having four feet of bellows extension, capable of the highest power work.

Without the microscope, but with a sliding easel in the wooden runners (an improvised optical bench), it makes a splendid 15 × 12 copying camera.

In Figure 4, it is shown as a vertical photomicrographic camera. An ordinary dissecting microscope stand, with a wide tube fitted to the arm, will be found to make an excellent substitute for the costly big microscope, especially when large wet objects are being dealt with. A Dunning's live cell is a very useful adjunct for such work, and a mess of water round the stage will do the stand no harm.

Figure 3, shows the camera as a purely vertical camera, plus a sliding glass platform on the same upright as the camera, upon which even such contrary things as eggs may be laid, a morsel of "Plasticine" on the underside preventing rolling.

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Or a glass tank may be set on the transparent platform, and here the apparatus is invaluable—difficult and fragile objects may be displayed in water, any suitable background can be put in below, or various tints easily tried, without disturbing the object.

Further, a fish or other object can be hardened in formalin in a lifelike attitude, or simply spread out in water. A background of weeds, sand, shells, and so on, can be arranged on an opal glass below, the object being raised up or down from the background on the sliding platform, till the correct effect and the absence of shadows has been obtained, and the subject photographed in apparently natural surroundings, with striking results.

To prevent reflections from water and wet preparations, a ground glass screen can easily be adjusted on the optical bench, as shown, or coloured glass to get orthochromatic effects without screens in front of the lens.

If need be, a condenser can be made to play a beam of light on the object, with no more trouble than adjusting it on the optical bench.

Figure 2 shows the apparatus being used as an enlarging and reducing camera, which can be used with or without artificial light.

The essential features of this apparatus are :—

1. A camera, sliding easily in a central groove, and giving about four feet of extension, with suitable fittings, as indicated.

2. An optical bench, with fittings, consisting of sliding platform for microscope, condenser, light and troughs or screens, also sliding fittings capable of taking a glass or board easel; all being centred on the bench.

This last is vital: to have all parts in alignment and centring adjustments to keep them so, is the secret of success. A camera of this type without an optical bench as a permanent fixture is only half finished, and will infallibly lead to waste of both time and plates.

In my opinion such a camera complete need not cost more than ten pounds, and could be made so as to secure some measure of portability.

JAMES WILLIAM TUTT, F.E.S.

ON January 10th, there passed away the well-known entomologist, Mr. Jas. William Tutt, who for the past twenty years has been the editor of the *Entomologist's Record and Journal of Variation*, and who, for many years, has been a regular attendant at, and participant in the work of several of our London Societies. He was a native of Strood, Kent, where he became a pupil-teacher, and from whence he passed to St. Mark's College for Schoolmasters. He entered the service of the London School Board, and having been promoted time after time, was last year selected to open one of the first of the new Central Higher Grade Schools, which are now being established by the London Education Authority. The study of insects was his hobby, and in spite of the onerous burden of his educational duties, his ability, capacity for work, and his forceful character, brought his writings many an eulogistic recognition, not only from all parts of the United Kingdom, but from many Continental circles as well as from America. At the time of his death he was President-elect of the great Entomological Society of London. For some years past he had been the editor of the annual organ of the South-Eastern Union of Scientific Societies. His earlier writings were more of a popular nature than his later work, and we may mention those admirable descriptions of country rambles, "Random Recollections of Woodland, Fen and Hill," and "Woodside, Burnside, Hillside, and Marsh." For the past fifteen years Mr. Tutt had spent his holidays in the Alps, and his enthusiastic nature pictures in "Rambles in Alpine Valleys," and in many articles written by him in the *Record*, have led numbers of our insular workers, including the present writer, to extend their narrow experiences and views, by investigating the insect fauna of numerous beautiful regions outside the routes of the ordinary superficial tourist. "The British Noctuae and their Varieties" was a book giving an intimation of the more serious work of which Mr. Tutt was capable. This was succeeded by "The Migration and Dispersal of Insects," "The Natural History of British Butterflies," and so on, works requiring much research and leading up to the commencement of a huge encyclopaedic work, which was of so ambitious a nature that one individual could only have imagined himself, even with long life permitted him, able to write but a small instalment. This was the "Natural History of British Lepidoptera" of which he issued eight volumes, and was at the time of his death engaged upon two more. Mr. Tutt had attracted around him an enthusiastic band of co-workers, Continental as well as British, and the original work done by these gentlemen, his own work and criticism, with a huge amount of all the best done in the past, he welded together with a master hand and had illustrated by the best men, acting under his skilful advice and supervision. The study of Entomology, by his death, has lost a huge force, and it will be long ere another can step in to fill his place.

HENRY TURNER.

THE SUN SPOT GROUPS OF 1906.

A SPECIAL interest attached to the Sun Spot groups of 1906, because in that year sun spot activity or prevalence was hypothetically at the end of the thirty-five year cycle which has been assigned to it, and should have reached its last maximum. Activity on the solar surface was much less in the early part of that year than in the corresponding period of the previous year. The last phase of the maximum spot period seems to have begun in the earlier half of 1906. A comparative calm prevailed till May 12th, when a great outburst of solar activity occurred. At the end of July two large spots appeared, both of which became visible to the naked eye during August. The larger of the two spots developed a great deal during its passage across the Sun's disc. When first seen on July 28th it appeared as quite a small spot and in the course of its transit had grown to ten degrees in length and six degrees in breadth. A period of calm followed, which was broken by a stream of spots lasting through November till the middle of December. In the next year, the maximum appeared to have been passed.

Dr. C. L. Poor, as the result of his discussion on the figure of the Sun, derived partly from a study of the solar photographs of the Rutherford series extending over several years, and also from the heliometer measures made by the German Transit of Venus Expeditions, concluded that the ratio of the polar to the equatorial diameter of the Sun was a variable quantity, and had relation to the presence or absence of solar spots. This is a conclusion which has since been disputed, but is one of the more interesting speculations with regard to the periodicity of sun-spot areas. Schur and Ambronn did not support Dr. Poor's inferences; and Dr. C. G. Abbott's recently published memoirs on the Sun, while favouring variations of solar radiation and brightness, does not relate them to variation in the Sun's figure.

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From a photograph taken at *The Royal Observatory, Greenwich.*

Sun Spot Group, August, 1906. 3d. 17h. 10m. Greenwich Civil Time. Enlarged two diameters.
Diameter of Sun's image 5 feet.

(See page 43).

SIR FRANCIS GALTON, D.Sc., F.R.S.

SIR FRANCIS GALTON, D.Sc., F.R.S., who closed a long life of many and useful activities on Tuesday, January 17th, after a very brief illness, was born on February 16th, 1822. He came of a long-lived family, a fact on which it does not seem superfluous to dwell, seeing how great a stress Sir Francis Galton laid on parentage and family in determining the characteristics of the individual. To his kindred and ancestry he attributed not merely his physical and mental attributes, but his predilections and his length of years. A reference to his work on "Noteworthy Families," which was compiled chiefly by reference to the Fellows of the Royal Society, discloses that on one side he sprang from the Galtons and the Barclays, and on the other from the Darwins. Among the Barclays was that Captain Barclay who astonished the early Victorian world by walking a thousand miles in a thousand hours, and it was to this strain that Sir Francis was accustomed to refer his own unusual power of enduring physical fatigue without harmful results. His longevity he attributed to the Darwins, and some of his mental powers must have been inherited from the same fount; but his paternal grandfather was a scientific man as well as a good man of business, and the Barclays, apart from the peripatetic Captain, were bankers. It was, however, to the commingling of ancestors that he owed, as he observed in his Reminiscences, a considerable taste for science, for statistics, and for poetry.

His education was not less composite than the qualities which were bequeathed to him by his progenitors. His mother would have had him become a physician like his grandfather, Dr. Erasmus Darwin. But he developed a mathematical gift and, after a boyhood spent at two French schools and one English grammar school, he went up to Cambridge as a mathematical aspirant. His fine health failed him there, however, and after a severe illness he left the University with nothing better than a pass degree. He used to say in after years that when he found himself one day elected to an Honorary Fellowship of Trinity College, he was so surprised that he thought it was a mistake. After Cambridge he walked the London hospitals, but here again he failed to find his vocation, and the death of his father found him with his career in life still undetermined. So, having private means, he went, like many another in the same case, on his travels. But his "wanderjahre" was prolonged. It comprised the Soudan as far as Khartoum—in the pre-Khalifa days—Syria and Palestine, all viewed under conditions very different from those of to-day. But his travels were actually his first passport to the world of scientific research, for in 1854 the Royal Geographical Society awarded him its medal for his explorations of Damaraland and Namaqualand.

But before that his marriage (in 1853) had settled him in England; and he began to interest himself specially in meteorology. He was associated with that Royal Observatory at Kew which is now a landmark for golfers; and among the important and permanent measures which arose from the association were the standardising of sextants and other angular measuring instruments, the verification of thermometers, the Kew rating of watches. Under Dr. Francis Galton, the old Kew observatory became the first English Reichsanstalt; the primitive ancestor of the National Physical Laboratories at Bushey. He did lasting work in meteorology while at Kew, and the term "anti-cyclone" as descriptive of a weather type which lately has overhung the larger part of Western Europe, was of his coining. The counter-clockwise movement of winds in cyclones had been appreciated and understood before his time, but the movements of the complementary atmospheric systems had received hardly any notice or explanation.

It is, however, Galton's work in heredity which seems now to have been his most important contribution to science. Heredity had always interested him; and his researches may be said to have been based on Gauss's theorem. Gauss supposed all variability to be due to different and equally probable combinations of a variety of causes. Galton desired to test this theorem by the light of those characteristics of human kind which are measurable. He therefore set up, in 1884, an Anthropometric Laboratory, in which were measured the more obvious characteristics, such as height, weight, span of arms, and so on, as well as the less obvious ones of keenness of sight, colour sense, lung capacity, reaction time, personal equation in various aspects. By examination of data thus derived he hoped to find what influence parentage had on the physical attributes of offspring—and for a generation he preached the multiplication and usefulness of such laboratories. It was while examining the Bertillon system of anthropometry that Galton developed another measurement of idiosyncrasy—the finger print—though in his Reminiscences he is careful to say that Sir William Herschel in India had experimented with finger prints as a method of identification since 1887; he gave priority of method to Mr. Henry Faulds, who is still living. As a necessary corollary, if indeed it may not be more properly described as the fount and well-spring of his work in anthropometry, arose his investigations in that science of "Eugenics," to which he gave its name; and which is the science (of right breeding) that aims at the discovery in man of those qualities which are desirable for his survival and progression. One may say in summation of his theoretic position, that he was a disciple of Weissmann rather than of Hering or of Butler; and that he was tempted to reduce the conditions of inheritance to a mathematical formula, as Pearson and the geometricians seek to do, and to suppose that each ancestor contributes a share to the individual proportional to the distances of relationship.

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CORRESPONDENCE.

POLAR PHENOMENA.

To the Editors of "KNOWLEDGE."

SIRS,—"Anxious" asks a question with reference to the period of slow motion of the Sun in the Arctic Regions. Perhaps the following investigation may throw some light on the problem.

Let QQ^1 be the celestial equator, and EE^1 the Ecliptic, the angle ω of inclination being 23° 28′ approximately. Let S^1 represent the sun when close to E^1, the Solstitial Point, and S the sun when in the latter.

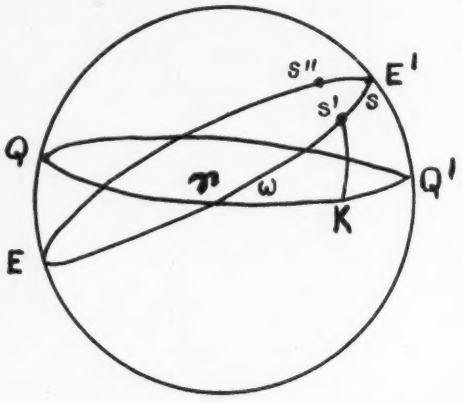

FIGURE 1.

Let δ be the declination at S^1, and $\delta+\Delta$ the declination at S, where Δ is very small. Let the arc S^1S be $\chi°$. (For the present we ignore the latitude of the place.) See Figure I.

Now, the problem is to find the value of the arc S^1S, and from this the number of days corresponding. Consider the spherical triangle $E^1Q^1\Upsilon$ sin E^1Q^1=sin ω sin ΥE^1, or (1) sin $(\delta+\Delta)$=sin ω, since ΥE^1 is 90°. Similarly, from the spherical triangle $S^1K\Upsilon$ sin S^1K=sin $S^1\Upsilon$ sin ω. Now S^1K is δ the declination, and $S^1\Upsilon$ is $90-\chi$

$$\therefore \sin\delta=\sin(90-\chi)\sin\omega$$
$$\text{or } \sin\delta=\sin\omega\cos\chi. \quad (2)$$

Subtract (2) from (1), and we have

$$\sin(\delta+\Delta)-\sin\delta=\sin\omega(1-\cos\chi)$$
$$\text{or } \sin\delta(\cos\Delta-1)+\cos\delta\sin\Delta=\sin\omega(1-\cos\chi)$$

Now Δ is very small, and $\delta=\omega$ approximately

$\therefore$ cos Δ=1, and (cos Δ—1) may be neglected in the above equation,

$$\therefore \cos\omega\sin\Delta=\sin\omega(1-\cos\chi)$$
$$\text{or } 1-\cos\chi=\sin A\cot\omega.$$
$$\cos\chi=1-\sin\Delta\cot\omega. \quad (3)$$

Now, let us suppose that Δ does not vary by more than one-fifth the Sun's diameter, say 6′. Such a small variation in the Sun's declination would practically give him the appearance of being stationary. Substitute in (3), 6′ for Δ

$$\cos\chi=1-\sin 6'\cot 23°\,28'=1-\cdot001746\times 2\cdot303=\cdot9959 \quad \therefore \chi=5°\,10'.$$

Hence S^1S is an arc of 5° 10′. As the sun will attain the same declination after passing through the Solstitial Point at S^{II} where $SS^{II}=SS^1=5°\,10'$, the actual arc traversed by the Sun, while his declination changes by 6′ is 10° 20′. Reckoning approximately 1° per day for his motion in the Ecliptic, the number of days during which the declination varies by 6′ is about 10½.

Now, suppose we allow Δ to vary by 10′, or about one-third the Sun's diameter.

In this case $\cos\chi=1-\sin 10'\cot 23°\,28'$
$=1-\cdot002909\times 2\cdot303$
$=\cdot9933005$
$\therefore \chi=6°\,38',\ 2\chi=13°\,16'$

and time is about 13 days.

Let Δ vary by 20′ : then $\cos\chi=1-\sin 20'\cot 23°\,28'$
$=1-\cdot00582\times 2\cdot303=\cdot986596$
$\chi=9°\,24'\ 2\chi=18°\,48'$

and the time is about 19 days.

Let us now assume a latitude of 86°½ say.

In Figure II *Z* is the Zenith, P the pole, HR the horizon for latitude 86½ : the arc *Z*P is then 90°−86½°=3½°. At the vernal equinox, the Sun, being in the equator, will describe the arc QQ^1, but when the declination is 3½°, he will not set, but at midnight will just graze the horizon. After this he will

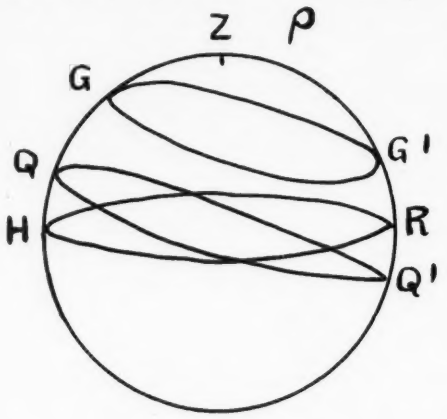

FIGURE 2.

continue to rise each day higher above the horizon, and at the Solstice his path during the 24 hours is the small circle GG^1. The time he appears to stand still is evidently the same for any latitude, for the changes in declination are in no way affected by the latitude of the place. Thus, though he does not set when describing the small circle GG^1, his declination is slowly changing at the rate of about 6′ for 10½ days, or 20′ for 19 days. This causes his diurnal path to suffer very little perceptible change during this period, and at a latitude where he rises and sets he will appear to do so almost at the same point of the horizon each day.

(REV.) M. DAVIDSON, B.Sc., B.A.

ASTRONOMICAL APPOINTMENTS.

To the Editors of "KNOWLEDGE."

SIRS,—I read Mr. F. A. Bellamy's letter with great interest, and many of us must agree with the justness of his remarks.

As a perfectly independent person I have often thought that they manage astronomical appointments much better in America, and that this accounts for the splendid work accomplished there in late years. I believe the Americans allow proved merit to guide their selections in some degree, and thus their great telescopes can be utilized by the best observers. If Barnard, Burnham, Brooks, Swift and others had worked in England they would have had to content themselves with such appliances as their own private means could provide. But in America their abilities were recognised, and they were placed in positions where observational skill and powerful instruments could be employed in combination. This was, it is true, owing to the beneficence of Lick, Yerkes, Warner and others, and it is, perhaps, curious that we very seldom read of such benefactions in our own country. In America it is not unusual to hear of liberal bequests on behalf of astronomy, but in England large sums are rarely, if ever, devoted to such a purpose. They are applied to building public libraries, benevolent institutions, laying-out parks, or some such purpose.

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When British millionaires fittingly recognise the claims of our sublime science, and apportion some of their wealth in furtherance of its progress, then our countrymen will be in a position to effect more rapid advances. The most capable observers should be given the use of the largest instruments, so that, from their work in unison with able mathematicians, valuable results would naturally accrue. It is not often that a good mathematician is a master-hand at observation. By mere examination in figures and eyesight it is not always possible to discover astronomical geniuses, or the men best qualified for astronomical observatories. Those should be selected who have previously exhibited abilities of a high order, and have gained experience necessary for the best work.

W. F. DENNING.

SPECTROSCOPIC DOUBLE STARS.

To the Editors of "KNOWLEDGE."

SIRS,—In your November number a correspondent inquires about the determination of orbits of spectroscopic double stars. To elucidate this fully in popular language is not easy, but I think the principle involved can be made clear. To take the simplest particular case, and considering one component of the binary system only, if during the period of one complete revolution the four intervals between the moments of maximum positive and negative velocities and the two zero velocities in the line of sight be all equal, a little consideration will show that the orbit must be circular, and the two maximum velocities, positive and negative, will be equal. In this particular case the data being insufficient to give a value for the inclination of the orbit to the line of sight, the linear dimensions of this orbit, which would vary inversely as the cosine of this angle of inclination, and hence also the masses of the stars, cannot be determined. In general the four intervals are all unequal, and the two maximum velocities are also unequal, and from a knowledge of these quantities and the known law of variation of the velocity in elliptic orbits, it becomes possible to calculate the inclination of the plane of the orbit to the line of sight, and thence the dimensions of the orbit and the total mass involved. It may make clearer the conditions involved if it is noted that at the moments of successive zero velocities in the line of sight the star is necessarily at opposite extremities of some diameter of its elliptic orbit, but at the moments of successive maximum velocities in the line of sight this is not so, but the positions are shifted to points in the orbit where the absolute velocities are greater, that is, to points nearer to the focus in which the centre of gravity of the system lies, and it is in effect these shiftings (which depend in amount on absolute velocities in the orbit), which make possible a solution of the problem. The case of a circular orbit considered above illustrates this, for since the absolute velocity in the orbit is constant, the positions in the orbit which give the maximum velocities in the line of sight are not shifted, and the problem is indeterminate. Practically in any case the solution depends on the determination of six quantities, the four intervals and two maximum velocities. To determine these with the greatest accuracy numerous observations at successive intervals of time are necessary. Needless to say, the measurements are of the utmost delicacy, and the proper combination of them makes a problem of great complexity. So far, only one component of the binary system has been considered. In all cases the orbits of the two stars are similar ellipses with a common focus, and in the same plane, but with their major axes oppositely directed, and if each component gives a measurable spectrum, the orbits and masses of both become completely known, but if one is a dark body or too faint, it is only possible to determine the orbit of the brighter component and the sum of the two masses. In cases of variables of the Algol type, the variation of the light during the partial eclipses gives further data from which some idea of the volumes of the stars can be obtained.

The degree of attainable accuracy varies very greatly in different cases; the most favourable conditions are when the orbits are much elongated, the period short, and the inclination of the plane of the orbits to the line of sight small. I believe that in the majority of well-observed cases the elongation of the orbits is considerable, and this would suggest an origin for these systems very different from that of our solar system.

J. H. G.

THE INCLINED POSITION OF THE APPARENT VERTICAL MERIDIANS OF THE EYES.

To the Editors of "KNOWLEDGE."

SIRS,—In answer to the communication entitled "Sloping Images" in the December number of "KNOWLEDGE," page 476, the facts are as stated. The whole subject of binocular vision is treated in the most thorough manner by Helmholtz in the "Physiologische Optik"; Leipzig, 1867. The chapter on binocular double vision begins at page 695; but I should recommend the student to consult first the historical *résumé* at page 762. The discussion of the vertical meridians begins at page 703; a number of measurements are given, and the inclination of the apparent verticals is deduced at about $2\frac{1}{2}°$ for normal eyes (705). Perhaps the most important suggestion is on page 715. I must premise that by the word "horopter" is meant the locus of points seen with both eyes as single points. The general form of the horopter is complex, and is the subject of abstruse mathematical investigation; but, in the particular case of a man standing or walking, looking straight before him, the horopter reduces to a plane, which practically coincides with the ground, as seen in this position. The distance of this plane from the eyes is governed by the convergence of the apparent verticals; and the point in which they intersect is the point of the horopter which lies near the feet. Helmholtz then suggests that the necessity, which exists in walking, of having clear vision of the ground where the foot is to be set, may be the origin of the convergence, and thus of the inclination of the apparent verticals.

The word "horopter" is derived apparently from the Greek words, ὅρος, a line, boundary, land mark; and ὁπτήρ, a seer, one who sees. The meaning does not obviously follow; but Helmholtz clearly means by it, "the assemblage or locus of points seen as single." The word was originated by Aguillonius, who used it to denote a plane, on which he supposed everything seen to be projected.

The subject is of great extent and great interest. There may, probably, be more modern developments, and there should certainly be some English book on the subject; but I do not know of any.

R. H. M. B.

THE MOON AND THE WEATHER.

To the Editors of "KNOWLEDGE."

SIRS,—You were good enough to insert in your September number a letter of mine on "The Moon and the Weather."

This year I have watched again, and carefully, and send you the readings below, taken 6 a.m. and 1 p.m.:—

Dec.	1	33—40	
„	2	38—38	
„	3	31—39	
„	4	28—30	$1\frac{1}{2}$" snow
„	5	32—40	
„	6	32—38	Snow, sleet, mist
„	7	32—39	Bright sunshine
„	8	40—42	Warm rain cleared off snow from fields
„	9	38—42	S.W. wind
„	10	34—38	N.E. to S.W.
„	11	26—40	N.E. to S.W.
„	12	40—47	S.W.
„	13	36—42	N.E. to S.W.
„	14	33—42	N.E. to S.W. Fog on the river
„	15	29—37	N.E. to S.W. Fog higher up

Dec. 16	...	38—38	...	N.E. to S.W. Fog higher
„ 17	...	34—40	...	N.E. to S.W. Fog on top of mountains
„ 18	...	34—36	...	Ditto
„ 19	...	34—36	...	Wind N.E. to S.W No mists
„ 20	...	28—36	...	Ditto
„ 21	...	31—40	...	Ditto
„ 22	...	31—33	...	Snow from S.E. falling on foot hills

You will see from the above that the high tides of December may have something to do with weather here.

While writing may I ask, Are there what are known as half tides anywhere except on Pacific Coast—what are known as a long run in and a short run out and a short run in and a long run out?

GEO. DITCHAM.

THE ETERNAL RETURN.

To the Editors of "KNOWLEDGE."

SIRS,—In a book by Mr. J. M. Kennedy, on the German philosopher Nietzche, the following theory is promulgated by the latter, the data being derived from the work of the great French astronomer La Place; and it appears that the same theory was evolved independently by Blanqui, the famous agitator, also Dr. Gustave Le Bon, and Heine, the German poet, and is said to be found in Ancient Greek Philosophy. I will endeavour to express it as succinctly as possible.

"Time and space are infinite, but the sum total of the forces in the Universe appears to be constant and determined. It is impossible to conceive their diminution or increase. There is therefore a sum of constant and determined forces not infinite. If these forces could ever attain a position of balance it would have already happened, as an infinity of time has passed, and the world would be for ever immobile, as it cannot be conceived that once attained such a state could alter. The sum total of these forces will bring about in infinite time a vast number of combinations, and produce some that have already been realised, and therefore the entire series of combinations that have existed. Universal evolution brings about the same phases, and travels round in an immense circle for all eternity, from which it follows that every identical individual has already lived the same life an infinite number of times and will continue to do so for ever." Dr. Le Bon expresses it thus: "If it is the same elements of each world which serve after its destruction to create a new one, it is easy to understand that the same combinations, viz., the same worlds inhabited by the same beings, may be repeated time after time, the possible combinations being limited and time unlimited."

I write to ask is there any flaw in this reasoning, and if so what is it? This theory seems to me to pre-suppose that every world is destroyed by collision with another before being renewed, but as space is infinite it is difficult to understand why a dead world may not continue to travel for ever without coming in contact with another. What ground is there for thinking that the sum total of the forces in the Universe is constant and determined? In an infinity of space one would suppose that these forces must pervade infinite space, as absolutely vacant space seems unthinkable. What is the opinion of scientists on the subject?

H. D. BARCLAY.

PODURA SCALES.

To the Editors of "KNOWLEDGE."

SIRS,—In reply to Mr. T. L. Smith's correspondence it is quite evident he has "blundered greatly."

It is not sufficient that his 1·4 objective, with cedar oil to the cover glass, be connected with the scale, in what Mr. Smith believes to be optical contact, to obtain an aperture of 1·4, but that the cone of light which impinges upon the scale shall also have as large an angle. Now this is impossible with scales simply mounted in air; the way Mr. Smith has his mounted (what other medium does he suggest is between the cover glass and the slip?) even supposing the scale really was in actual contact with the cover all over—he will understand I cannot possibly agree that this is so under the circumstances appertaining—beneath the scale and above the glass slip is—what? Air? Now, even if using an oil immersion condenser of 1·4 made homogeneous with cedar oil to the slip, so soon as the cone of light had passed through this, into the air space—however small—down would drop the aperture to 1·0, as air cannot possibly convey a greater angle than this between two parallel surfaces.

This fact is used as the standard or starting point of refractive indices, and known as the "normal of air." If, again, he had the scale mounted dry between two cover glasses, as he says, truly this would make "confusion worse confounded"; in the first place it would simply throw his condenser out of correction, as they are all corrected for a certain thickness of slip, and should he have used a dry condenser he would have had two layers of air instead of one for the light to pass through. It is quite evident he has forgotten one of the principles of microscopic vision, and that is, it is not the actual object he sees when looking through the eyepiece, but simply an image of that object formed some distance up the tube of the microscope, and given an incident air angle of 1·0 upon an object it would not matter if an objective of 2·40 were immersed upon it—the resolving power would be no greater than 1·0. Again, if, when looking down the tube he thought he was getting 1·40 N.A., and which I have shown could not possibly be more than 1·0, he *further* closed this aperture until only three quarters of that opening was visible, he was actually getting much nearer ·75 than 1·40, an aperture not so great as a good dry quarter inch objective would have given him as regards resolving power. The cover glass idea might also be shown to be fallacious from the very fact that such a small stratum of air intervenes, apart from condenser uncorrections.

There is an axiom also which seems so often neglected, that the visibility of very minute structure is proportional to the difference between the refractive index of the object and the medium in which it is immersed,—which I particularly tried to emphasize in my previous letter—and that it is essential if the whole aperture of an objective is to be utilized to mount such minute structures in some medium other than air. As this has never been done successfully (so far as I am aware) with the Podura Scale he will be able to realize what I mean when I say that "here, then, we make no advance upon the very earliest methods." Until such a medium is found and the scale successfully mounted, we are left with the only alternative in contrast between the 1·0 of air and the 1·5 of the scale itself, a practicability of vision of ·5 only. It may be —I cannot say—that with vertical illumination a slightly greater angle than 1·0 might be obtained, but that, it seems to me, would only help us with surface structure chiefly, and as this runs one into the province of the optician's art, I cannot venture to trespass.

I have not yet heard of a dry objective which can give an aperture of 1·0, and Mr. Smith's explanation of the "tilted light to the object" in the microscope and the "moon it is that revolves" are really too abstruse for me.

In conclusion, I must apologise for my photographs being too small for good reproduction, but if Mr. Smith would allow the Editor to forward me his address, I should be pleased to send him an actual enlargement of them, which would allow him a much clearer view, I feel sure, than he can have at present of their purport. I am obliged for his open remarks and candid reply, and would like respectfully to suggest this little experiment for him to make: take a slide, say, of Pleurosigma or Amphipleura, mounted in Realgar, and using his 1·40 objective immersed upon it, also a good condenser of 1·40 immersed to the under slide of slip. Now when the object is in focus and the light axial, take out the eyepiece and measure the diameter of light coming through the objective—then, take away this slide and substitute the slide of Podura,

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mounted dry on cover of the glass slip, using the same immersion objective and condenser, and when in focus upon the object, again take out the eyepiece and remeasure the diameter of light coming through. I think when he has thoroughly mastered this apparent elasticity of his 1·40 objective, he will have made good progress in the study of aperture, and, I trust, pardon me for the suggestion.

Yours faithfully,

F. J. W. PLASKITT.

QUERIES AND ANSWERS.

Readers are invited to send in Questions and to answer the Queries which are printed on this page.

QUESTIONS.

Numbers 16, 17 and 18 (December number, page 461), and 21 (January number, page 39) still remain unanswered.

26. LUNAR ECLIPSE.—What, for parallel red rays, is the *minimum* length of focus of the Earth and its atmosphere, regarded as a centrally-stopped lens?

ISIS.

27. MINOR PLANETS.—Excluding the Berlin Year-Book as being rather too expensive, is there any yearly publication which gives the ephemerides of the first score or two of the brighter Minor Planets, or of any of them whatsoever beyond the first four? Mention of the price and place where procurable would oblige.

ISIS.

REPLIES.

10. WATER AND ITS OWN LEVEL.—In Mr. Mercer's reply (page 39) the word *not* in the concluding phrase was omitted; it should have read: "While in the wider sense we must also "not" forget that the earth has a great power of attraction, and so the gravitation of the earth makes the oceans take the shape of the globe."

10. If a level surface is defined as a mathematically plane surface then, except in imagination, no such thing exists in nature, and "water finds its own level" is neither true nor false, but simply meaningless, no definite level surface existing from which to measure. The curvature of a puddle is exactly the same as that of a still ocean, and if by level is meant the imaginary plane which touches the surface of the water at a given point, the statement that water finds its own level is false, but it is very approximately true for distances which are very small compared with the radius of the earth, and it is in this restricted sense that it is used.

J. H. G.

20. THE DISTANCE OF THE SUN.—I think it may be asserted categorically that no reward ever has been, or ever will be, offered for the discovery of a more accurate method of determining the sun's distance. Offers of reward are not likely to elicit new methods in abstract science.

This distance is probably known with an error of about one part in two thousand, that is, about two feet and affew inches in the mile, and if anyone discovered a new method which would reduce this error by even so much as six inches, I imagine the corrected distance would have but faint interest for any scientific man, it would be the one thing in the discovery of little moment, since it would certainly shortly be further corrected. The discovery of the novel method itself is quite another matter, and might well be of the greatest importance being almost certainly capable of application in many directions; as to the discoverer, he would probably feel the discovery itself sufficient reward. The Edisons and Marconis of the world are usually made of stuff that knows how to find its own reward, and no one grudges it them; the world has need of such; but the gifted discoverers of new methods in science look for their reward in a different direction, and I fancy are generally fairly satisfied with what they get, though it may not have been so at all stages of the world's history. It is always dangerous to prophesy, but seems hardly likely that any really novel method will be discovered. What is certain is that the use and development of the already known methods will continually reduce remaining error, and not improbably the next few years may see even more than the six inches mentioned above wiped out.

J. H. G.

22. RADIUM.—It is now accepted that radium is a disintegration product of the element uranium (at. wgt.=239). In minerals, the ratio of radium to uranium exhibits a constancy, as the former element has had time to reach its equilibrium amount. This ratio appears to be about $3{\cdot}8 \times 10{-}7$ gram per gram of uranium. Owing to the comparatively feeble activity of uranium, its period (*i.e.* time of half-transformation) is enormously long,—about 5×109 years, and certain products intervene between it and radium, viz: Ur. X and ionium. Uranium, therefore, passes into radium through intermediate stages, and so long as these disintegration products remain associated with the uranium in the mineral, radium and all *its* disintegration products are maintained in their equilibrium amounts, while all *non*-active products gradually increase. In this way the α particles (atoms of the gas helium, (at. wgt.=4.), become occluded in radioactive minerals, and this occluded helium increases in quantity with time. The theoretical rate of evolution of helium can be estimated with fair accuracy, and by comparison of the calculated annual evolution of helium per gram of the mineral with the actual amount found occluded in it, an estimate of the age of any active mineral can be made. The method may not be entirely free from uncertainty, but there can be little doubt of the general correctness of the values found, which amount in some cases to hundreds of millions of years.

As to the origin of uranium itself, it is hardly possible to speculate. As no element of higher atomic weight is known, we cannot assume it to be a disintegration product. The same question as to origin might be asked of any element,—we have always the problem of the evolution of the elements before us.

CHARLES W. RAFFETY.

23. THE GULF STREAM.—It is thought now, by many of those who have studied the subject, that the influence of the Gulf Stream on the climate of the British Isles is by no means so great as was formerly believed to be the case. Owing to investigations made in the North Atlantic ocean, and examinations of samples of sea water taken by the "Challenger" and "Michael Sars" Expeditions, it is found that the Arctic Current which flows past the coast of Labrador cuts into the tropical water brought north by the Gulf Stream off Newfoundland, and considerably modifies the temperature.

The question as to how much of the actual current from the Gulf of Mexico crosses the Atlantic is a complex question, and requires further investigation, for it is found to vary at different times.

The climate of the British Isles is largely affected by the eastward drifts from the North Atlantic, which consist of heated waters from the Equatorial regions, and these flow north-eastwards as a warm surface current into the Arctic Seas.

F. ROSS THOMSON, F.R.G.S.

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24. DREAMS.—I am convinced, after twenty years of experience, that the scientific position with respect to dreams is, that they may have an *objective* as well as a subjective origin. J. C. W. rightly says "*expects and it happens*"; we hear coming upon our sleeping horizon, "Here is the Queen of Heaven," and we wake to find the full moon beaming into our faces; the sensation experienced between the sleeping and the waking is as a centripetal concentric curtain shutting. Such are common to those who enjoy or suffer from a cosmic telepathy; an intelligence sensed as within and without, and which communicates with the clairaudient, often to his dismay and terror. Interpretation should be guarded; the phenomena are certainly *not always* subjective. We know this is the case by such experiences of a *sensed expectation becoming a realisation* occurring as the lower notes of a gamut, of which the higher notes are an inter-communication of brain to brain as perfect as a telephone, and which is known to theosophists and others. The most scientific book on dreams is by Dr. Sancte-di-Sanctis, "I Sogni," but his first edition in not recognising the *objective* possibility of dreams, is, like the great classic books on psychology and mental pathology, deprived of half its value. To those who know first-hand telepathic phenomena, there are no secrets which can be hidden, and the demonstration of a disembodied intelligence is ever sensed and accepted by them as an elementary natural phenomenon, not of necessity spiritual, but a form of radiant energy, and to which a few may possess the key—even human beings.

J. B. S.

25. TIDES.—J. H. G. has made some slip in his question, when he says that with *deep* oceans the tidal protuberance should be behind the moon with *direct* Tides. I think that, perhaps, if he re-reads pages 240–242 of Darwin's Tides he will see that he is mis-stating the facts. He is unquestionably right in saying that the whole subject might, with advantage, receive more notice in popular accounts. I may refer him to "Chapters in Astronomy," by Claudius Kennedy.

J. A. HARDCASTLE.

SOLAR DISTURBANCES DURING DECEMBER, 1910.

By FRANK C. DENNETT.

DECEMBER has been marked by a still further decrease in solar disturbance. On six days out of the twenty-three on which it was found possible to observe, no spots, maculae or faculae, were visible, and on six others only faculae were noted. At noon on December the 1st, the longitude of the central meridian was 342° 52′.

No. 89.—A group of three larger pores with smaller points close up, seen on the 11th; after slight changes it had dwindled to a poorly-seen marking, on the 15th, when last observed.

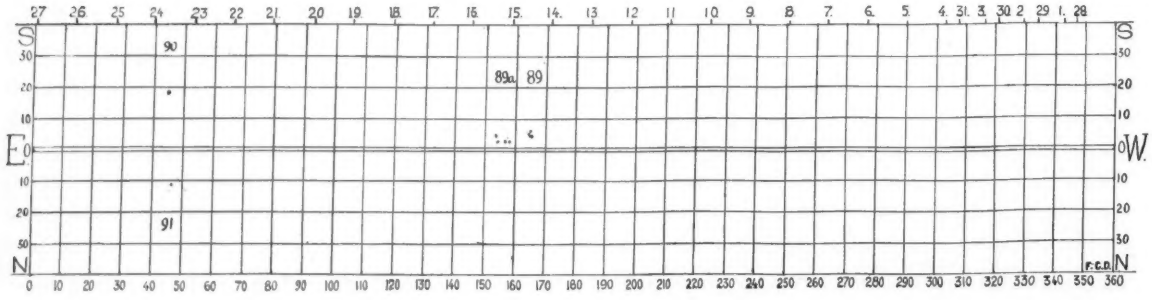
No. 89*a*.—A triangular group of spotlets, from the 11–13th; the rear spots were not seen after, but pores had developed in front of the preceding one on the 14–16th, but it was not seen after. The length of the group was 30,000 miles.

No. 90.—A small spot had come round the eastern limb and dwindled away from the 18th until the 22nd, when last seen. A faculic disturbance was observed in the same area on the 29th, which may possibly have contained a pore.

No. 91.—A pore amid a small faculic disturbance, only recorded on the 28th.

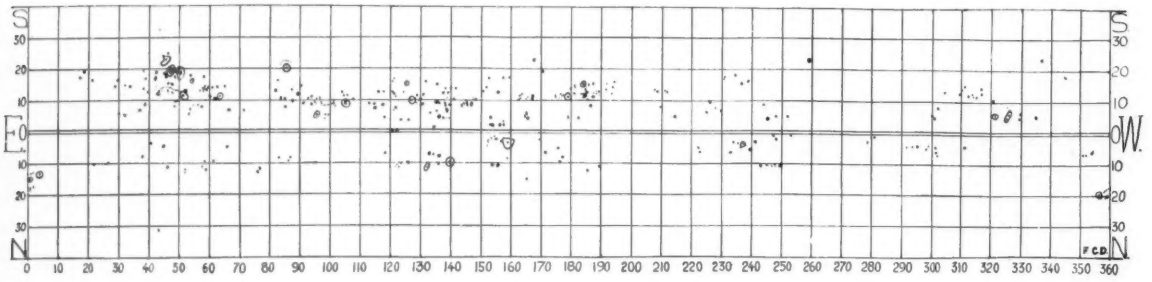
The chart is constructed from the combined observations of Messrs. J. McHarg, A. A. Buss, E. E. Peacock, and F. C. Dennett.

DAY OF DECEMBER.



The second chart shows the distribution of the dark spots upon the entire surface of the sun during the whole year. Ninety-one primary and thirty-one secondary outbreaks, of which eighty-nine were in the southern, and thirty-three in the northern hemisphere. It will be noted that certain areas appear to be far more subject to disturbance than do others.

DISTRIBUTION OF SPOT DISTURBANCES DURING 1910.



BRITISH EARTHQUAKES.

By CHARLES DAVISON, Sc.D., F.G.S.

EARTHQUAKES, according to their nature and origin, may be divided into three classes—simple, twin and complex. In simple earthquakes the shock seldom exceeds a few seconds in duration, and its intensity increases to a maximum and then dies away. In twin earthquakes the shock consists of two distinct parts, separated by an interval of rest and quiet, lasting, as a rule, for two or three seconds, each part resembling a simple shock in nature and duration. Complex earthquakes are usually of considerable duration and great violence. They may last as long as three or four minutes, and there are many fluctuations of intensity and frequent changes of direction. Corresponding to this difference in nature there is also a diversity in origin. In simple earthquakes the focus consists of a single region, near the centre of which the initial impulse is greater than elsewhere. In twin earthquakes there are two such regions, almost or completely detached from one another. In complex earthquakes the focus consists of many portions, which may or may not be directly connected, and the violence of the shock is due partly, as in simple and twin earthquakes, to the friction of sliding rock-surfaces, partly to the rapid translation of the rock-masses themselves. In other words, the movement which gives rise to the shock is not as a rule permanently perceptible at the surface in simple and twin earthquakes, while in complex earthquakes it often remains manifest in the form of fault-scarps and horizontal displacements.

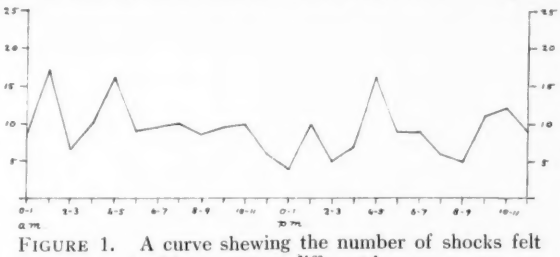


FIGURE 1. A curve shewing the number of shocks felt in this country at different hours.

Whatever may have been the case in times past, this country is now, fortunately, exempt from all earthquakes of the complex order. Occasionally, about once in ten years, a shock causes damage to houses within a limited area, but the houses affected are usually of an inferior class. The great majority of our earthquakes are so slight that they would have passed unnoticed if they had not occurred during the hours devoted to rest and sleep.

FREQUENCY.

During the last twenty-one years (1889–1909), in which the greater part of my spare time has been devoted to the study of British earthquakes, the total number known to me is 250, or almost exactly one a month. The number of disturbances described as earthquakes in newspapers is of course considerably larger, but many of these disturbances prove on investigation to be artificial or partly artificial in their origin. Many of them are caused by the firing of heavy guns at a distance, their true character being generally revealed by the explosive nature of the sound, the apparent transmission of the waves through the air and not through the ground, and by the increasing confidence with which observers in one direction attribute the shock and sound to gun-firing. Others are due to the explosion of meteorites; a few, and their spurious origin is soon detected, to the explosion of dynamite or powder magazines. An interesting class of local shocks is found to be confined to mining districts. They are often of considerable intensity within a very small area, but are imperceptible at a distance of a few miles from its centre. They may sometimes be caused by the fall of masses of rock from the roof of the workings, but most of them appear to be caused by slips of the superincumbent strata along a fault-surface, the slips being started by the withdrawal of rock from the workings or by that of water in pumping. During the last twenty-one years not less than seventeen local shocks are probably due to this cause.

Now, just as many slight shocks are wrongly confused with earthquakes and must be eliminated as far as possible from our earthquake-catalogues, so a large number may also escape detection, or, at any rate, record. They may be attributed to artificial operations, such as blasting, gun-firing, thunder, or the passing of a distant train or vehicle. There is other evidence than mere probable supposition. The curve in Figure 1 illustrates the number of shocks felt in this country during the different hours of the day. It shows that they are recorded more frequently during certain hours, and especially from 1 to 2 a.m., 4 to 5 a.m., 4 to 5 p.m., and 9 to 11 p.m. But the varying frequency is, in all probability, more apparent than real. All earthquake-catalogues founded on personal, and not instrumental, records, show the same increase of frequency late in the evening and in the early hours of the morning. It is no doubt due to more favourable conditions of

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observation. The streets are quiet, observers are generally lying down, and when they awake, as persons often do between 1 and 2 a.m., they are in a nervous condition, their senses are alert and ready to detect the slightest movement. The increase in frequency from 4 to 5 p.m. seems to be due to similar conditions. Of the sixteen earthquakes recorded during this hour, seven occurred on a Sunday afternoon, and others possibly in the restful interval devoted to an early tea. Now, as shocks recorded instrumentally show a tendency to greatest frequency about local noon at any place, it follows that the slight shocks, which are only perceptible under the conditions alluded to above, must be much more numerous than our catalogues would lead us to suspect. We shall probably not be over-estimating their number if we consider that twenty earthquakes occur in this country on an average every year.

PERIODICITY.

Whether there be any real variation of frequency throughout the day must for the present remain uncertain in the case of British earthquakes. For this purpose the only records of any value are those which are registered by properly erected instruments, isolated completely from all artificial disturbances. Personal observations are, however, sufficient to determine whether any annual variation exists in the frequency of earthquakes, for there is no reason for supposing the conditions of observation to be sensibly better at one time of the year than another. In Figure 2, the continuous line represents the numbers of earthquakes recorded during the different months, account, of course, being taken of their varying lengths. The curve, it will be seen, is irregular, the monthly number of shocks being greatest in September and December. The actual frequency of earthquakes may, however, be due to different causes, which may be themselves subject to variations of different periods,—just as, when a chord is played on any instrument, the movement of a particle of air in its neighbourhood is compounded of several movements, each with a different period corresponding to those of the notes that are struck. To separate out the different periods which produce the actual variation in frequency, some method of harmonic analysis must be employed, and, as great accuracy is not essential, the method of overlapping means will be be found sufficient for the purpose. The method consists in finding consecutive six-monthly means of the monthly numbers of earthquakes. Thus, the mean of the numbers for the months from November to April inclusive, corresponds to the middle of that interval, that is, to the end of January; the mean of those for December to May corresponds to the end of February, and so on. In this way the broken line in Figure 2 is obtained. The effect of taking six-monthly means is to smooth the curve by eliminating or reducing periods of six months and less. The broken line therefore, represents with sufficient accuracy the annual variation in frequency of British earthquakes. The maximum of the annual period, it will be noticed, falls in October, that is, in the middle of two months when the actual frequency is less than in the two months of September and December on either side. A similar method may be used for determining whether a six-monthly period exists, but the resulting variation is not pronounced enough for us to feel convinced of the reality of a period of this length. All that we can regard as proved is that there is a marked annual periodicity, and that its maximum occurs in October and its minimum in April.

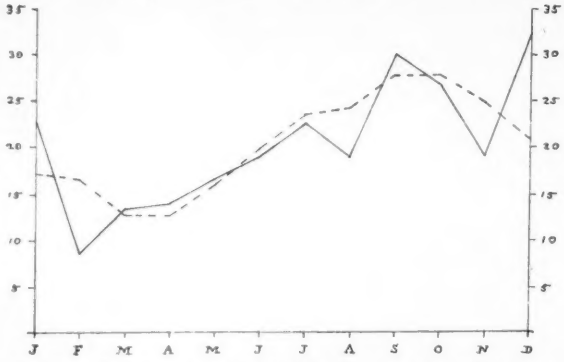

FIGURE 2. A curve representing the number of shocks recorded in this country during different months of the year.

INTENSITY.

The intensity of an earthquake is generally denoted by its greatest intensity within the central region of the disturbed area. For this purpose an arbitrary scale is used, known as the Rossi-Forel scale. In this there are ten degrees, the two lowest and the two highest being inapplicable to the earthquakes here considered. The remaining degrees are as follows, only one test being given under each heading; the shock being strong enough:

Intensity

3 for the direction or duration to be sensible;
4 to make doors, windows, and so on, rattle;
5 to cause the observer's seat to be perceptibly raised or moved;
6 to make chandeliers, pictures, and so on, swing;
7 to overthrow ornaments, vases, and so on;
8 to throw down chimneys or crack the walls of some houses.

Of the two hundred and fifty earthquakes, three were of intensity 8, nine of intensity 7, seven of intensity 6, twenty-nine of intensity 5, sixty-four of intensity 4, one hundred and twenty-seven of intensity 3 or about 3, while the remaining eleven were merely sounds without any tremor being felt.

As a rule, of course, the area disturbed by an earthquake increases with its intensity, the average disturbed area of an earthquake of intensity three being one hundred and twenty-six square miles, and of one of intensity eight about sixty-six thousand square miles. Earthquakes of the same degree of intensity are, however, felt over widely differing

areas. For instance, for the intensity seven, the disturbed area may be as low as one thousand square miles and as high as sixty-three thousand six hundred square miles; for the intensity six, the area ranges from seventy-four to three thousand one hundred square miles; and so on. Thus, actual intensity near the centre cannot be regarded as a measure of an earthquake's strength. Nor, on the other hand, as some seismologists maintain, can the extent of the disturbed area be employed as such a measure, for this area depends on several conditions, of which one of the most important is the time of occurrence. For instance, the Pembroke earthquake of 1892 was felt over forty-four thousand eight hundred and sixty square miles, and the distinctly weaker shock of 1893 over sixty-three thousand six hundred square miles, the reason being that the former movement occurred at 0.24 a.m. and the latter at 5.45 p.m. In like manner the disturbed areas of the Derby earthquakes of 1903 and 1904 were twelve thousand and twenty-five thousand square miles, the former occurring at 1.30 p.m. and the latter, which was somewhat weaker, at 3.21 on a Sunday afternoon. In each case the disturbed area of the earlier shock was bounded by a line of intensity four, and of the latter by one of intensity three. On the whole, if area is to be used at all as a measure of strength, it would seem better to employ the area within a given isoseismal line, or line of equal intensity, say that corresponding to intensity four. For British earthquakes it is convenient to regard as *strong* all those in which this area exceeds five thousand square miles, as *moderate* all those in which it lies between one thousand and five thousand square miles, and as *slight* all those in which it is less than one thousand square miles. Making use of this convention it would appear, then, that during the twenty-one years considered there have been in this country nine strong, seven moderate, and two hundred and twenty three slight earthquakes, and eleven earth-sounds.

DISTRIBUTION.

There is very little approach to uniformity in the distribution of British earthquakes. Some parts of the country are frequently visited, others only rarely, or not at all. Thus, of the total number, fifty originated in England, twenty-seven in Wales, and one hundred and seventy-three in Scotland. In the latter country certain limited districts are subject to numerous shocks. Thus, in the low-lying country between the Ochil Hills and the Firth of Forth eighty-three shocks were felt, several of them of intensities six and seven; in Glen Garry, in Inverness-shire, forty-one shocks, all of them slight; while, in the small tract lying along the line of the Caledonian Canal between Inverness and Loch Ness, thirty shocks originated, two of them disturbing areas of seven thousand five hundred, and thirty-three thousand square miles.

In England, the country between Hereford and Ross has been visited by thirteen shocks, one of them the strongest felt in this country during the last quarter of a century, in whichever way strength be measured. In Derbyshire, between Ashbourne and Wirksworth, eight earthquakes have occurred, two of them strong. Other parts of the country are not specially favoured, with the exception perhaps of the county of Cornwall, to which ten slight shocks must be credited.

The Welsh earthquakes are occasionally of considerable strength. They occur for the most part in three districts, one being in the north-west of Carnarvonshire, the others in the south of the country, in Pembrokeshire and Glamorgan. They number among them four of the nine strong earthquakes, and all four, it may be noticed, were felt across the channel in the eastern and south-eastern counties of Ireland.

Only a small part of Great Britain has been undisturbed by any sensible earthquake during the twenty-one years, the only unshaken districts being the extreme north-east of England and the southern part of Scotland. The greater part of Ireland has entirely escaped from all terrestrial disturbance, and, so far as I know, not a single earthquake has actually originated during the interval considered within the area of this island.

NATURE OF THE SHOCK AND SOUND.

The first intimation that we generally receive of the coming earthquake is a low rumbling noise. Within a second or two, as the noise grows louder, a tremor begins to be felt, the separate vibrations being small and occurring at the rate of about five or six a second. Within two or three seconds these merge into the main part of the shock, consisting of larger vibrations or jolts, with a period of perhaps one-third of a second and a total range, even in the strongest earthquakes, of probably only a fraction of an inch. Close to the centre these vibrations have been described as like the fierce beats of a railway engine travelling rapidly; but at a distance of fifty miles or more they become smoother and slower, like the movements felt in a carriage with good springs. During the whole of this time the rumbling sound continues, becoming louder and more grating with the principal vibrations, and occasionally interspersed with deep explosive crashes. As a rule the strong vibrations begin to die away after two or three seconds, and are succeeded by a weaker tremor and noise, until, finally, after the lapse of six or eight seconds, both die away, the sound continuing for perhaps a second or two after the shock. The total duration of the shock in a strong earthquake is thus from six to eight or nine seconds.

In slight earthquakes the phenomena are much simpler. Sometimes only a tremor is felt, lasting for at most two or three seconds, and accompanied by the usual rumbling noise; but, as a rule, among the tremors, and generally at the beginning, one prominent vibration is felt, so that it seems as if a heavy weight had fallen with a thud upon the ground, with the brief quiver following as such a thud might be expected to cause in a building.

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The sound which forms so essential a part of an earthquake is a low, rumbling or grating noise. Near the centre it is heard by all observers, but as the distance increases it becomes inaudible to a larger and larger percentage of persons. The reason is that the number of vibrations occurring every second is very near that which forms the lower limit of audibility, or about sixteen to thirty-two a second; and, with a slight decrease in strength, these vibrations fail to affect the ear. Moreover, this limit varies in different persons, so that some, and not others, are able to hear the sound. Thus, in one place, and even in the same house, one observer will declare that the shock was unaccompanied by sound, while another will record a noise louder than thunder or than many traction engines passing together.

Some observers find it difficult to describe the sound, remarking that it resembles no noise with which they are acquainted. The majority compare it to some well-known types. Those most frequently referred to are the rapid passing of heavy waggons, traction-engines, steam-rollers, or railway trains, on a hard road, over a bridge, or through a tunnel; the deep roll of thunder, and generally distant thunder; and the rising of a strong wind or a chimney on fire. Less frequently in strong earthquakes, but more often in slight ones, we have comparisons to sounds of short duration, such as the tipping of a load of stones, the fall of a heavy muffled weight, the firing of a distant gun, or a blast in a quarry.

By most observers, by two out of every three, the sound is heard just before the shock begins. A smaller proportion, about two out of every five, hear the sound after the shock is over. In many foreign countries the sound is heard before the shock only, and this has led to the impression that the waves which form the sound travel more rapidly than those which form the shock. The true explanation of the discrepancy is that the British, as a race, are more capable of hearing low sounds than most other people. They possess a lower limit of audibility, which, in earthquake-countries, may be of service in enabling them to escape into the open air with the first rumble of the on-coming earthquake. That the two series of waves travel with approximately, if not quite, the same velocity is evident from the fact that, in strong earthquakes, the percentage of observers who hear the sound before the shock, and also of those who hear it after the shock, is almost exactly the same at all distances from the origin. If there were any appreciable difference in velocity, the sound and shock would soon become separated from one another.

SIMPLE AND TWIN EARTHQUAKES.

The great majority of British earthquakes belong to the first of the three classes mentioned at the beginning of this paper. Of the two hundred and fifty earthquakes, two hundred and thirty-nine were simple, and eleven twin. The latter include, however, most of the strong shocks felt in this country. Of these, nine in number, two were simple earthquakes, the average area disturbed by them being twenty-nine thousand square miles. The remaining seven were twins, and disturbed, on an average, an area of forty-seven thousand square miles. The latter include also the four strongest earthquakes of the period considered, namely the Pembroke earthquakes of 1892 and 1893, the Hereford earthquake of 1896, and the Swansea earthquake of 1906. The average disturbed area of these four earthquakes is sixty-eight thousand square miles, or three-quarters of the total area of Great Britain.

Another point in which simple and twin earthquakes differ is in the number of minor shocks which attend them. The total number of such shocks during the twenty-one years is seventy-one, all but five of which preceded or followed the nine strong earthquakes and the Inverness earthquake of 1890. This earthquake, which belongs to the class of simple earthquakes, just falls short of the test required to place it among the strong earthquakes. The area included within the isoseismal of intensity four, is four thousand three hundred and forty square miles, and the area disturbed by it about seven thousand five hundred square miles. Of the sixty-six minor shocks which attended these ten earthquakes, fifteen were fore-shocks and fifty-one after-shocks; and, of the after-shocks, thirty-three followed the three simple earthquakes, and eighteen the seven twin earthquakes. In other words, the average number of after-shocks of a simple earthquake is eleven, and of a twin earthquake between two and three.

MINOR SHOCKS.

Besides the slight shocks which are intimately connected with the strong earthquakes, there have been two series of shocks, for the most part of slight intensity and confined to certain limited districts. Both of these districts are in Scotland, and are responsible for the large number of slight shocks felt in that country. The first series lasted for about twelve years, from 1888 to 1899, and were confined to Glen Garry, a valley in the west of Inverness-shire. In this interval fifty slight shocks were recorded, but owing to the mountainous character of the district little more is known about them than their time of occurrence and their nature at one or two places. The shock was invariably a slight tremor of very brief duration, and accompanied by a sound compared most frequently to a carriage passing, but occasionally to thunder.

The series of earthquakes felt chiefly in the district lying to the north of the Firth of Forth and south of the Ochil Hills is more interesting, on account of the larger number of observers, though here again the presence of a range of hills to the north prevents us from determining the disturbed areas of all but the strongest shocks. This series began with four shocks in the year 1900, and then ceased, with one exception in 1903, until 1905, when both the number and intensity increased. In this year ten were recorded, one of them being felt over an area of a thousand

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square miles. In the four succeeding years, the numbers observed were nineteen, thirteen, seventeen and eighteen, and they show no sign at present of abating in frequency or strength. During the ten years 1900–1909 the number felt was eighty-three. They are interesting from their probable connection with the great fault which skirts the southern side of the Ochil Hills, which, notwithstanding its advanced age, still seems to be growing. The small movements, which give rise to the earthquakes, appear to be limited to the portion of the fault between Airthrey (near Bridge of Allan) and Tillicoultry, and to take place at a very small depth below the surface.

OBSERVATIONS IN MINES.

Isolated observations have been made in mines in many cases, both in this and other countries, the general result being that the shock is more feebly felt in mines than upon the surface of the ground. Several recent British earthquakes have occurred within or near mining districts, and these, especially the Derby earthquake of 1903 and the Swansea earthquake of 1906, have thrown further light on an interesting subject. They confirm the previous impression that the shock is more manifest on the surface than underground; indeed, the disturbed area in mines is only a small fraction of that upon the surface. On the surface, again, the sound in strong earthquakes is heard over an area much smaller than that within which the shock is felt. In mines the sound is observed as far as, or farther than, the shock. Some interesting observations were made on the sound in mines in the two earthquakes referred to. They show that the sound appears to travel through the rock overhead rather than through that below, but this is only the case at distances of more than five miles from the centre. Again, in both earthquakes, there is some, though not decisive, evidence showing that the intensity of the shock increases with the depth of the workings below the surface. This point is one on which it would be worth while to make careful investigations in future earthquakes.

ORIGIN OF BRITISH EARTHQUAKES.

The most interesting result to which the study of British earthquakes has led is the proof of their connection with the slow growth of faults. The longer axes of the isoseismal lines are parallel, or very nearly so, to the main faults of the central district, or, if the faults be unmapped, to the principal lines of folding. The centres of the earthquakes lie on the side towards which the fault-surface is inclined, and at a short distance (generally a mile or two) from the fault-line. When many after-shocks occur, as with the Inverness earthquake of 1901, their centres lie within a narrow band parallel to the fault, and again on the side towards which the fault-surface slopes. It is possible, indeed, to trace the migrations of the seismic foci from side to side along the fault, and gradually, as the series come to an end, towards the surface of the earth.

The occurrence of true earthquakes in this country is therefore decisive evidence that the growth of British faults, ancient as many of them are, is not yet at an end. This is not the case, of course, with all our faults. The great majority are, perhaps, at rest, possibly have altogether ceased to grow. But some, it may be a very small minority, have kept themselves by constant, if slight, exertions free to move. That the absolute displacements are of small account is evident from the fact that they are so seldom destructive to property. But the displacement to which any one earthquake is due extends over a considerable area. In the Carlisle earthquake of 1901 and the Swansea earthquake of 1906 the total length of the focus exceeded twenty miles.

The length of the focus of an earthquake can only be determined roughly; in any particular case the error may amount to one, or several miles. But there is a curious relation between the average length of focus in the different classes of earthquakes. In strong earthquakes this average length is twelve and a quarter miles, and in moderate earthquakes thirteen miles. Slight earthquakes may be divided into two well-marked groups. In one the focus is nine miles or more in length, and the average length twelve miles; in the other the focus is six miles or less in length, and the average length four miles or less. Further evidence on this point is afforded by the nature of the sound. Dividing the types of comparison into two classes, according as they are of long or short duration, we find that the percentage of references to types of long duration is eighty-four for strong earthquakes, eighty-one for moderate earthquakes, eighty-four for slight earthquakes with a long focus, and sixty-three for those with a short focus. Thus, except for the slightest of all earthquakes, the average length of focus is practically the same in all three classes. Their difference of intensity depends only on the amount of displacement within the focus.

There must be some reason for this close correspondence in average length of focus. What the reason is cannot at present be definitely settled, though it can be surmised. The late M. Marcel Bertrand published a map of France on which are depicted the courses of the anticlines and synclines of the great folds which traverse the rocks of that country. The average distance between successive anticlines or crests, measured along several lines at right angles to them, varies from nine to twelve miles. For this country no similar map, so far as I am aware, has been prepared. But it is at least a probable supposition that the average distance between the crests of the great crust-folds does not differ widely in the two countries. If this be the case, then it would seem that the length of a crust-fold, or distance from crest to crest, may govern the length of the displacements along the faults which intersect them. In other words, the growth of the faults to which our earthquakes owe their origin is at present chiefly due to the growth of the transverse crust-folds.

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THE VATICAN OBSERVATORY OF TO-DAY.

By W. ALFRED PARR.

ALTHOUGH it was not until comparatively recent years that the Vatican Observatory entered upon that active phase of its existence which recognises in it the well-known and well-equipped *Specola Vaticana* of the present day, it is, in reality, one of the most venerable European institutions dedicated to the service of the heavenly science; for its early history dates from a period which precedes the foundation of our own national observatory at Greenwich by nearly a century, while it can claim intimate connection with one of the most epoch-making events in the annals of Astronomy. The significant appearance on its official seal of the Ram's Head, symbolical of the sun's position at the vernal equinox, still serves to commemorate this event—the reform of the calendar, under Gregory XIII—which may, indeed, be said to have called the observatory, as such, into being, as it was the famous meridian line, drawn by Ignazio Danti about 1580, to demonstrate to the Pope that the sun no longer entered the sign Aries on the orthodox date of March 21st, assigned to it by the Council of Nicaea in A.D. 325, that represented the nucleus around which astronomical instruments of all kinds soon collected to form the embryo of the present Vatican Observatory. A reform of the calendar had been proposed and discussed as early as 1414, but as the accumulated error in Gregory's time amounted to more than ten days, a circumstance which seriously affected the date of Easter, the long-desired amendment, projected by the Neapolitan astronomer, Lilio, and more fully demonstrated by the Jesuit Clavius, was established by Gregory in 1582, who, by this means, conferred a lasting *éclat* on his pontificate. As is well known, this reform, enforced "under pain of excommunication" throughout the Roman Catholic world, met with the greatest opposition in those countries which did not recognise the papal supremacy, and it was not adopted by Germany until after the energetic representations of Leibnitz and others in 1700, nor by Great Britain until more than half a century later, when its establishment by Act of Parliament caused the members of the calendar-reforming government to be mobbed in the streets of London by the populace, who, imagining they were being defrauded of their natural rights, noisily demanded the restitution of the eleven days, which, by that time, had to be suppressed in order to set chronological matters on an accurate footing.

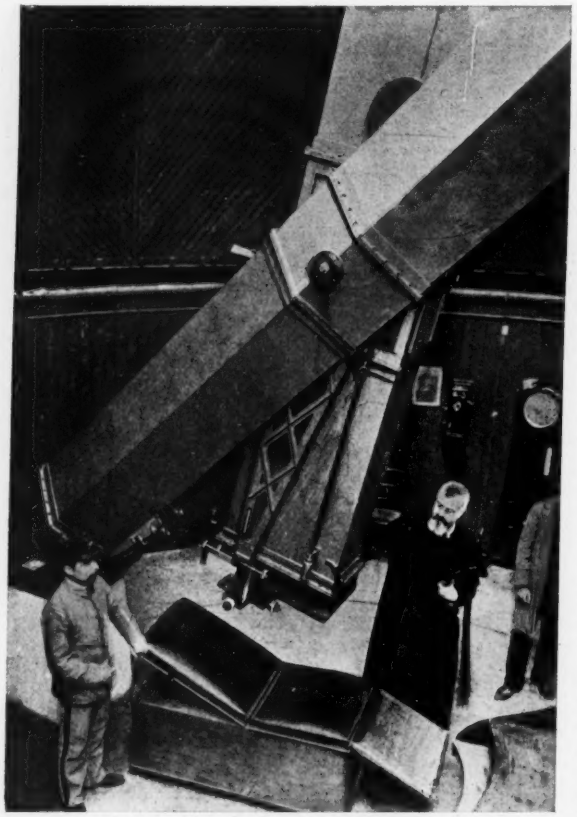

FIGURE 1.
The Astrographic Refractor.

Danti's meridian line was contained in that lofty portion of the Vatican Palace known as the *Torre dei Venti*, and this "*turris astrorum speculatrix*," as it was referred to in the inscriptions, remained for over two centuries the only astronomical, as it was until recently the principal meteorological, station of the Vatican. The output of work, however, was at first but small and intermittent, and long periods of "repose" alternated with sporadic outbursts of activity, a notable manifestation of the latter quality occurring towards the end of the eighteenth century, when Gilii, by unremitting diligence in observation, succeeded in restoring some measure of prestige to the venerable institution, which, it is interesting to find, had already acquired, in addition to other notable instruments of the period, a Dollond achromatic telescope from England. Meteorological, however rather than astronomical work now absorbed the energies of the observatory, for it had been found that the proximity of the great dome of St. Peter's unduly circumscribed its southern view, thus rendering the site less favourable for astronomical observations than that occupied by the observatory of the Collegio Romano, which had then but recently (*i.e.*, in 1787) been founded by Calandrelli, and

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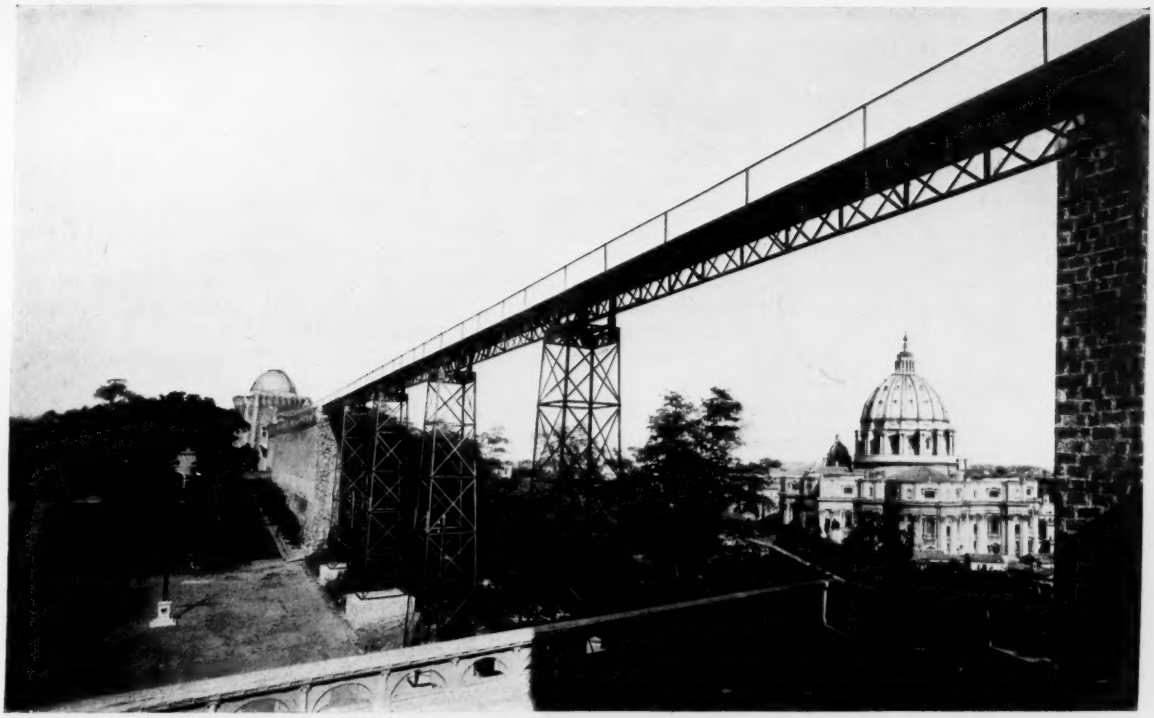

FIGURE 2. The Dome containing the sixteen-inch Refractor, and the Bridge connecting the Observatories.
Seen from the terrace over the Grotto of Lourdes. St. Peter's is on the right of the picture.

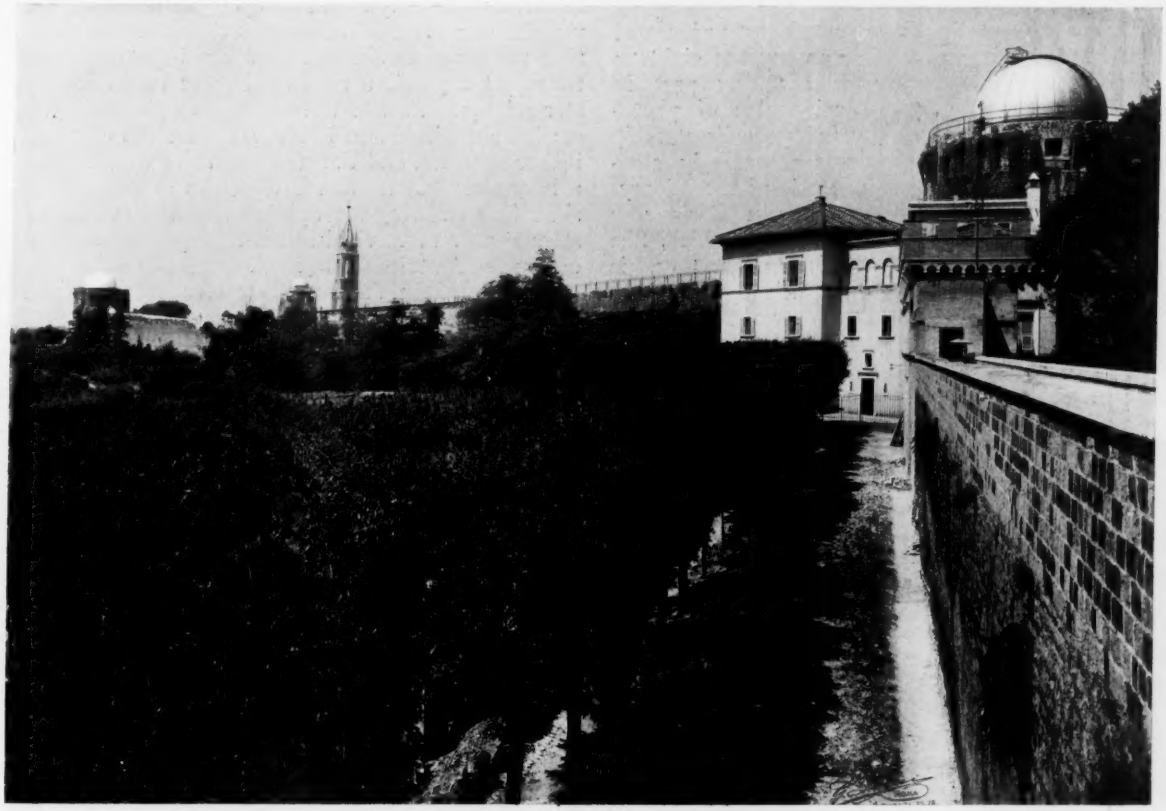

FIGURE 3. A nearer view of the Refractor Dome with attached dwelling house, shewing also other domes and the spire over the Lourdes Grotto.

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which was later to become so famous through the labours of De Vico and his illustrious successor Secchi; and thither, at the recommendation of Boscovich, the astronomical portion of the instruments was accordingly transferred. For an astronomical observatory to be deprived of its instruments would seem sufficiently fatal to its existence, but worse was to follow. After the political events of 1870, when the Italian troops took formal possession of the Eternal City, and Pius IX entered upon his self-imposed imprisonment in the Vatican, the old *Torre dei Venti*, owing to the sudden demand for room, was finally transformed into dwelling apartments!

But a glorious resurrection was now approaching. When Leo XIII celebrated his jubilee in 1888, a scientific exhibition was held in Rome to celebrate the event, and a considerable number of astronomical and meteorological instruments figured amongst the numerous presents received at the Vatican. After the close of the exhibition the question naturally suggested itself, What should His Holiness do with all these scientific instruments? Fathers Denza and Lais, who had had charge of the scientific section, at once proposed that the collection should be utilized to reconstitute the Vatican Observatory, and as the project found immediate favour with the Pope, who was himself not only a mathematical prizeman of earlier years, but a man of high intellectual attainments generally, it was rapidly pushed forward, with the gratifying result that the newly-reconstructed institution was soon enabled to claim a place among the eighteen great international observatories taking part in Admiral Mouchez's comprehensive plan of photographing the entire heavens. Under the directorship of Denza, a *zona vaticana* was accordingly commenced with the arrival, in 1893, of the Henry-Gautier astrographic telescope from Paris (see Figure 1). This instrument, however, which, like the similar one at the Paris Observatory, is mounted on the so-called English system, was no longer placed on the old "Tower of the Winds"—now given over to the housing of the archives—but in a free position some four hundred meters distant and on the summit of the Vatican hill, far from all disturbing influences. To ensure its best performance, moreover, it was mounted on one of the massive turrets (see Figure 5) forming part of the ancient fortifications erected in the ninth century by Leo IV, who, converting the tribute offered by the Emperor Lothair to this practical end, thereby sought to put a stop to the frequent incursions of the Saracen hordes. Despite the curious anachronism involved in providing a highly specialized instrument of the nineteenth century with a foundation dating from the ninth, the experiment proved an unqualified success, and the remaining towers of the Leonine wall were one by one pressed into the service of science as the observatory acquired additional telescopes. Four modern observatory-domes now surmount these ancient ramparts in a line, and as the distance separating the extreme domes is something like half a kilometer, the Vatican astronomers may be said, with Professor Turner, to be living in space of one dimension only. Nor is the uniqueness of the situation diminished by the fact that for a space of about eighty-five meters where Leo's cyclopean masonry has yielded to the ravages of ten centuries, a slender steel bridge (see Figure 2), the gift of a wealthy American, has replaced the massive walls, thus enabling inter-communication between the domes to be maintained.

The largest dome, nearly nine meters in diameter (see Figures 2 and 3), covers the new sixteen-inch visual refractor by Merz, which ranks with the similarly sized instruments at the Collegio Romano and at Dr. Vincenzo Cerulli's private observatory, Collurania, at Teramo, as one of the largest telescopes in Italy after the nineteen-inch Merz refractor of the Brera Observatory at Milan. It was mounted by Gautier, of Paris, after the advent, in 1906, of the present director, Father J. G. Hagen, who left the observatory of Georgetown, Washington, to assume the astronomical leadership at the Vatican. His monumental work, the *Atlas Stellarum Variabilium*,* which was prepared in America and completed at Rome, undoubtedly marks an epoch in the study of variable stars, and it is a great satisfaction to know that the same careful observer has been for some time past engaged upon an extensive research into star-colours. These latter investigations have been carried out with a small Merz refractor of only four inches aperture, and Father Hagen has already paid a handsome tribute to the clearness of the Italian skies in expressing the opinion that the colours of stars appear more vivid at his new post than they did on the American continent.

The site of the Vatican Observatory might indeed arouse the envy of many a larger and less favourably situated institution, and the writer having, through the courtesy of the director, as well as of Dr. Cerulli (who kindly furnished the introduction†), but recently enjoyed the privilege of visiting the institution, can bear witness to the natural advantages of its position, no less than to the natural charm of its surroundings. Nature, Science, and Art appear here in the happiest alliance. A spacious vaulted apartment in the great tower, now bearing the sixteen-inch refractor, had been utilized by Leo XIII as an audience chamber, and is decorated in an ingenious manner. The constellations visible from the latitude of Rome are painted, together with their appropriate figures, upon the domed ceiling, which thus represents the celestial vault, and as the various human figures standing for *Gemini*, *Virgo*, and so on, are most artistically treated,

* For an able review of this fine work, see *Journal, British Astronomical Association*, Vol. xvii., page 407.

† I take this opportunity of acknowledging my indebtedness to these gentlemen for the material aid they have afforded me in collecting the notes for this article.

the impression of the whole, which is the work of the well-known painter, Seitz, is an exceedingly pleasing one. The constellation *Leo*, in honour of the late Pope, is not only shown at its culminating point, but its principal stars are replaced by minute electric glow-lamps, so that their effect, when lighted, is very charming. Hard by, in the Vatican gardens, a surprise of a different kind, but also conceived in honour of Leo XIII, awaits the visitor, in the shape of a large open-air den containing the two magnificent lions presented to His Holiness by the Emperor Menelik. As in Rome itself, that city where of all others the centuries may be said to meet, and where the works of widely distant ages unite in strangest contrast, so in that portion of it represented by the Pope's garden the juxtaposition of incongruities is not wanting. Mention has already been made of electrically-driven observatory-domes and steel girder bridges crowning the mighty bulwarks of a bygone day, but this is not all. Midway between the observatories themselves there rises the slender spire of the chapel surmounting an exact replica of the famous grotto of Lourdes, with its bubbling spring of healing waters all complete!

Father Hagen, however, has succeeded with masterly skill in uniting the various outlying departments of his observatory into one organic whole. New instruments have been purchased, new measuring apparatus introduced for the measurement of the astrographic plates (one of the chief tasks of the observatory), and new work set on foot; while the substitution of a spectroheliograph, on Professor Hale's system, for the existing photoheliograph will probably take place in the near future. With so able an observer at the head of affairs, assisted as he is by the energetic coöperation of Fathers Lais and Stein, the Vatican Observatory, now fully reconstructed, and equipped with modern appliances, has certainly entered upon one of the brightest periods of its long career. The massive character of its foundations, the seclusion of its position in the midst of the Vatican gardens, and the singular purity of the Roman sky under which it works, all conspire to render its observations of exceptional value.

FIGURE 4.
The Dome containing the Photoheliograph.

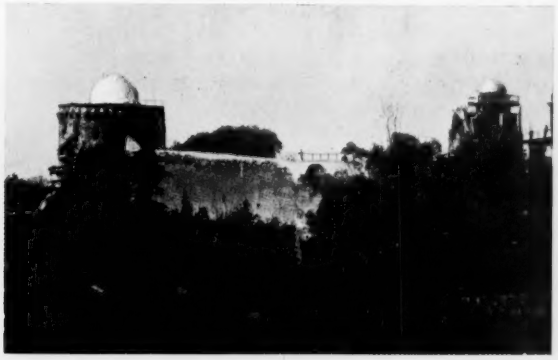

FIGURE 5.
In this Dome is the Astrographic Refractor.

DEMONSTRATION OF THE PRESENCE OF STARCH IN A LEAF.

IT is customary to hold, in connection with the Annual Meeting of the Association of Public School Science Masters, an exhibition of scientific apparatus and books likely to be of use in science-teaching. The show is divided into two parts, one consisting of exhibits by members of the Association, and the other of displays by opticians, instrument-makers and scientific publishers. There was an exceedingly fine exhibition at the January meeting, and the present writer was particularly interested in a modification, devised by Mr. O. H. Latter, of Charterhouse, of the usual experiment to demonstrate the presence of starch in a leaf which has been exposed to sunlight.

For those who do not know the details, one may say that a leaf is exposed to sunlight for some hours, gathered, boiled in water for a few moments, and the green colouring or chlorophyll, dissolved out by means of methylated spirit. In turn the alcohol is washed out by water, and finally the leaf is placed in iodine solution, which turns the starch blue. Although it is possible to get an intensely blue colouration of the leaf, especially if a suitable one has been chosen, and iodine dissolved in a solution of potassium iodide has been used, as the writer can testify by experience, Mr. Latter thinks that this method of showing the leaf when in the iodine solution makes a considerable demand upon the imagination; for he describes the colour produced as a dull purple-brown, that is, a mixture of the colour produced in the starch with that in the other constituents of the leaf.

His plan is to remove the leaf from the iodine and place it at once in benzole. The benzole then dissolves out the iodine from the cellulose walls of the cells and from the protoplasmic contents, but does not break up the blue starch-iodine compound. Hence the blue colour shows up very plainly in the leaf, being no longer masked by the yellow-browns of the iodine stained cellulose and protoplasm.

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NERVES AND NERVOUSNESS.

By DAVID FRASER HARRIS, M.D., B.Sc. (LOND.)

(Lecturer on Physiology, University of Birmingham.)

(Continued from page 22.)

THE answer to-day to our question is that we do know something of the material basis of nerve energy, although only a few years ago we should have had to confess complete ignorance. We believe it to be related to microscopic granules named after a German neurologist, Nissl. These granules of Nissl are known to break up in cells that are fatigued, but to be reformed when the cells have rested, so that we infer they are connected with the output of energy. In various mental diseases they are altered, also in alcoholic poisoning: the brain is never in good health if these granules are not of normal aspect. It is these granules which contain a high percentage of phosphorus. Long before they were discovered it was known that nerve-matter possessed much phosphorus, and hence arose the popular notion that to gain nerve-strength one ought to eat foods containing much phosphorus—fish and animals' brains for instance. Now while it may be good to eat fish and brains, the notion underlying the practice is based on the fallacy that we can increase the amount of any element in the tissues provided we eat food containing much of it. But the fact is we cannot in this way over-saturate the tissues with any given element: the tissues can absorb (assimilate) only a certain quantity of it, corresponding to their particular chemical affinity for the substance in question. In conditions of health this affinity limit cannot be exceeded, but it is otherwise in cases of pathological deficiency of the element in question. For instance, a healthy man by taking a great deal of iron in his diet will not cause a greater quantity of it than normal to be retained by his tissues; but the case of a person who has not been absorbing enough iron is quite different. If now capable of absorbing it, he may, by taking foods rich in iron, bring up the iron-content of his tissues to the normal but not beyond it. The case of phosphorus is similar. If for any reason the central nervous system has been starved of phosphorus, then food containing it may be given with advantage, but the phosphorus-content of the brain cannot be raised above the normal. Wasting diseases of the central nervous system certainly involve loss of this element which ought to be compensated for. The same reasoning applies to phosphatic tonics. They may benefit the body in certain ways, but they cannot become the means of increasing the percentage of phosphorus beyond its normal in the nerve-tissues.

We may now ask ourselves what is it that keeps up the continual outflow of impulses from the centres to the periphery? The answer is that this energy is liberated in the special granules already alluded to by the inpouring of afferent impulses constantly arriving at the centres of the nervous system. When one thinks carefully about it one sees that a vast number of all sorts of impulses must be pouring into the nervous centres both from all the sense-organs as well as from the internal organs. Sensory impressions from the organs of vision, hearing, smell, taste and from the skin—those of contact, pressure, heat and cold—and others of a less well defined nature from internal organs are continually arriving at the nervous system. Painful impulses are from time to time also coming in. We are not, of course, conscious of a tenth part of all these, but they are pouring in nevertheless; some of them even in sleep, when those from the skin and internal organs are still entering the nervous system. The nervous system is never without some incoming impulses, and we are powerless to prevent the entrance of the vast majority of them. Just as the hum or roar of the traffic of a great city pours into the room when the window is opened, so do the afferent neural impulses pour into the brain and spinal cord. The general tendency for these impulses is to cause the nerve-centres to discharge; that all the centres are not simultaneously discharged is due to a large number of coöperant conditions. Some impulses may be too feeble to arouse the first centre encountered, as when the fly is not felt until it has stung you; but a series of such too feeble impulses may, by being summated, effect what no one of the series is able to do. Or, again, two impulses may meet and interfere with each other in such a way that no action is aroused, just as when two sound-waves meet in a particular fashion and give rise to silence, or two colour-waves to blackness. This last case is one of "inhibition by interference" of neural currents.

There is no doubt that the general incoming neural "hum" goes to produce those outflowing currents which maintain the unconscious general

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tissue-tone. In proportion as we cut off the multitude of incoming impulses so tone vanishes; as, for instance, in sleep, in which no impulses are coming in from the higher sense-organs, and therefore the centres for tone to a large extent are unstimulated.

Keeping animals in the dark and in silence lowers their tone: cows kept in dark byres secrete poorer milk than those in well lighted ones. This is due to the depressed chemical tone of the cells of the mammary gland. It has been experimentally proved that if the afferent nerves from a limb are cut, the muscles of the limb suffer diminution of tone. It is evident, therefore, that the afferent nerves and the efferent nerves are functionally very closely related through the intermediation of their common centre. The entire nerve-path from the periphery, up the afferent nerve through the centre and down the efferent nerve is known as the "reflex nerve-arc." A vast number of the functional units of the central nervous system can be looked upon as reflex or "sensori-motor" nerve-arcs. These arcs are continually receiving impulses one way, and sending them out the other way, that is transmitting them in one fixed direction only. The impulses which go out are not identical with those that come in; in many cases, although they come in continuously, they go out intermittently by special rhythms of their own.

Now the intensity of the response given by a centre depends upon two things—first the intensity of the incoming impulse, and secondly its own condition of being affected by the stimulus easily or the reverse (Affectability). This applies to all centres, whether those in the cord unrelated to consciousness, or those in the brain related to perceptions, emotions, ideas and the will. Now one form of nervousness is that associated with an abnormally violent response to a stimulus. This form of nervousness is that of the "nervous temperament" as opposed to the phlegmatic, for there is more than a grain of truth in the old classification into lymphatic or phlegmatic, nervous, sanguine and melancholic temperaments. The nervous temperament has in recent times merely been rechristened "neurotic." A neurotic person is one whose nerve-centres are, as compared with those of the majority of people, unduly affectable. This condition of undue affectability manifests itself in many very different ways. If a hundred people are in a hall and a door bangs loudly, three of them may jump up from their seats while the other ninety-seven merely turn their heads in the direction of the sound; the three would be for the company in question the representatives of the neurotic constitution. The physical intensity of the stimulus was presumably the same for the whole hundred, but it produced a greater effect on three of them because their nerve-centres were in a state of excitability greater than the average for the particular company in the room at the time. Again let us suppose a hundred people come into a place where there is a large bowl of powerfully perfumed roses: ninety-seven appear indifferent and settle down to various occupations; one is visibly delighted with the odour; a second says, "That is a smell I detest," while the third gets an attack of asthma. The last three are "nervous" as regards the neural average of the assembly. Their nervous systems are unduly affected by the perfume of roses; the form it takes in one is distinct aesthetic pleasure, in a second well-marked aesthetic pain, in a third it gives rise to a motor effect, a spasm of the muscles of the bronchial tubes. This last is known as an attack of asthma; it belongs to a class of conditions called neuroses. Neurotic people exhibit neuroses. A neurosis is an excited or excitable state of some centre or centres of the nervous system expressing itself in an outflow of nerve-energy into such channels as injuriously affect certain organs or tissues. Nervous attacks or "attacks of nerves" may be taken as the popular synonyms for neuroses—fits of trembling, limbs shaking, "the quivering like an aspen leaf" of the novelette, palpitation and other visible effects of fear on the approach of an ordeal ("stage-fright," examination fright), blushing, blanching, perspiring, dilatation of the pupil, and in some cases even vomiting, all well-known results of stimulation of lower centres acted on by impulses descending from higher ones. Popularly the "nervous" person is the one who blushes, pales or perspires too easily, whose centres for these expressions of emotion are abnormally affectable and are set in motion by conditions which would have little or no effect on a person perfectly normal as regards the nervous system, a person with what is called a "well-balanced nervous system." What, however, is the cause of the abnormal affectability of the centres in a nervous person it would be difficult to say. In many cases it is probably due to malnutrition of the centres. Nerve substance is chemically only a very complicated form of fat, and fat people are almost never neurotic. We must not jump to the conclusion that because a person is fat his nerve-centres are of necessity well nourished, though they usually are. There are various kinds of obesity, some not indicating good nourishment; but as a rule it is lean people who are nervous. This is, of course, what Shakespeare alludes to when he makes Caesar say—

> "Let me have men about me that are fat;
> Sleek-headed men and such as sleep o' nights:
> Yond' Cassius has a lean and hungry look:
> He thinks too much: such men are dangerous."

Of course we must distinguish between the thin, pale, neurotic person, and the thin, "wiry," fit person whose nerve-centres may indeed be affectable without being abnormally or weakly affectable. For there is the healthy, robust nervous system with plenty of nerve-energy able to be discharged, and there is the weakly, excitable system with little energy always tending to leak away. The two conditions are quite different. The ease of response to a stimulus is one thing, the amount of energy liberated by a stimulus quite another thing. The same amount of pull will fire off a pop-gun

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and a "twelve inch," but the amounts of energy liberated by these equally excitable mechanisms are immeasurably different. In other words, there is a high affectability coupled with the output of much nerve-energy, and there is a high affectability coupled with the output of little: this latter constitutes "irritable weakness" ("weakness to be wroth with weakness"): it is this that is the basis of neuroses, of nervousness. The brain-centres related to consciousness ought to exert on the lower centres a restraint that is learnedly called "inhibition." Inhibition or restraint by the higher on the lower plays a large part in the activities of the central nervous system. Persons neurally robust have inhibition well developed, nervous people have it poorly developed. Inhibition is of two kinds, that unconsciously and that consciously exerted. The former is the more mechanical kind of restraint which any one centre exerts on any one lower down in the neural scale. Thus it is that when the head is cut off, the posterior part of a worm wriggles more actively than the head end; it has lost the automatic restraint of the head end. The legs of a decapitated crayfish "work" much more rapidly than in the intact animal. We may ourselves employ this form of mechanical inhibition in restraining, for instance, an awkward sneeze by firmly pressing on the upper lip. The otherwise uncontrollable tendency to sneeze is abolished by the impulses from the skin of the lip; they act here as inhibitory. That it is only inhibition of the tendency and not removal of it is interestingly brought out sometimes by the fact that after a certain interval of time the sneeze may be produced in what would have been all its original intensity. The stillness of an attentive audience is a case of unconscious inhibition; the subsequent coughing and restlessness is evidence that it was only inhibition and not abolition that was at work. But by means of the will we can consciously inhibit or restrain. What we call "education" is very largely the cultivating of latent powers of this order; the psychological difference between a Hottentot and an ambassador is the high development of the powers of inhibition acquired by the latter. Training in children and animals means their acquiring inhibitory powers: a performing tiger has to restrain many instincts and tendencies before it can be conveniently exhibited in public. Now some forms of nervousness are the result of loss of inhibition resulting in the expression of violent emotions and violent responses of all sorts. The strong man is not the violent man; the strong man is the man who restrains the exhibitions of his strength, who strongly controls strong emotions for his own good and that of the community. The neurotic person, not possessing the necessary power of inhibition, does not do this. Better is "he that ruleth his spirit than he that taketh a city": that was written long ago, but the nervous system was the same then as now; in modern language it is inhibition that is alluded to. Nervousness may, then, in one form be a condition of diminished restraint. We talk about a nervous dog that barks apprehensively at every little incident, of a nervous horse that jibs and shies at all sorts of harmless objects; inhibition is that in which these animals are deficient. It is, then, clear that the development of inhibition is the essence of foundation of character: a person with little inhibition may do all sorts of wild things, succumb to all sorts of temptations: conscious inhibition is the physiological name for self-control. Lack of inhibition is one of the elements in neurasthenia, that low nervous state to which reference has already been made. Hysteria, again, is a form of nervousness; it is a morbid state of the central nervous system, and has been described as the acting or imitating of some other disease. "A fit of hysterics" is really a violent emotional display due to diminished inhibition. In true hysteria all sorts of morbid conditions are imitated,—fainting, paralyses of various kinds, and so on. Some hysterical people cannot walk, cannot talk, cannot eat, cannot get out of bed, and so forth. Hysteria is a form of "nervousness," if "nervousness" means anything unusual in the nervous system, which is apparently all that in certain cases it does mean. The term as popularly used covers a large number of very different conditions. By a nervous child is meant sometimes a shy child, one not sufficiently self-reliant, who shrinks from strangers, and is not soon at home amid new surroundings. It may only mean a child that does not like to be left alone in the dark.

A very well marked form of nervousness is the "fear" of various conditions, such as fear of looking over heights, fear of open spaces, fear of enclosed spaces, fear of the presence of crowds, and so on through all the various "phobias," as they are called, many of which are ludicrous to those incapable of experiencing them. Allied to hysterias and phobias are certain harmless obsessions which, however, lead right on to the illusions, delusions, and hallucinations of typical mania.

In connection with nervousness we have the factor of *suddenness* to reckon with. Something happening without warning will *un*nerve a man or animal which it would not do had the occurrence been foretold or developed gradually. Just as a sudden knock will break a glass, which the same pressure cautiously applied would not, so a sudden mental blow will injuriously affect the nervous system in a way it would not have done had it fallen more gradually. Both non-living and living molecules resent sudden changes of state; both can endure strains if gradually applied which would not be withstood if applied without warning. Especially should the affectable and plastic nervous systems of children be protected from sudden impacts. Permanent damage may be done them by "taking them by surprise," "giving them frights," suddenly showing them "horrors" and so forth. The nervous system will "endure" (almost) "all things" provided they are presented to it in graded order: it may be trained by degrees to suffer conditions which if suddenly developed would have overwhelmed it altogether

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SOME MAORI CUSTOMS AND BELIEFS.

By R. W. REID

(New Zealand).

THOUGH the Maoris of New Zealand are rapidly adopting the civilisation of the whites, they seem reluctant to part with many of the customs and beliefs of their forefathers. The settlement of the country by the British and the introduction of British law rendered the old mode of life impossible. Most of those peculiar observances witnessed by early navigators and others, which were opposed to English ideas, had perforce to cease. But long-established social customs, when not very harmful, albeit not always strictly legal, were never, and are not now, subject to interference from the authorities. Keen recollections of early days in New Zealand, while police, courts, and judges were yet unknown, abide to-day in the memories of not a few grizzled and tattooed veterans. Thus the writer's friend, Hori (the distinguishing appellation had better be here omitted!) a Bay of Plenty chief, is able to confide to those he deems worthy of being entrusted with the interesting autobiographic information, that, when a young man, he, on several important occasions, did partake of "kai tangata." An unsuspecting enquirer, learning that "kai" is Maori for "food," and that "tangata" is the equivalent to "man," might hastily conclude that "kai tangata" represented an article of diet neither uncommon nor alarming. Hori, however, could explain that, used by him, the phrase meant, not "the food of man," but "man, the food," and that, in ancient Maoriland, was a difference indeed.

Polygamy, never a common practice among Maoris, and generally confined to men of rank, is now almost extinct. An official report of recent date states that there are only three or four cases of Maoris having more wives than one, and that these are among the Ruatahuna natives on the Bay of Plenty. Rua, who lives in the Urewera country, and claims to possess certain supernatural powers, six months ago had eight wives. Very likely he has more now. He is the most married inhabitant of New Zealand; the Maori next to him possesses but the relatively modest number of three. When a dweller in pah or kainga (village) dies, the event is followed by a "tangi" or weeping. If a chief, or person of importance, his "tangi" is attended by hundreds of Maoris; relations and friends are there, and, in addition, nearly all the natives of the district. The proceedings are not infrequently prolonged over many days, and become a medley of formal weeping, of feasting and of merriment. Immense sums are often expended on tangis; the cost may vary from £50 to £500, according to the rank of the deceased and the financial capabilities, or inclinations, of his relatives. Among the very old, and more curious customs which survive is that of "tapu." By that wonderful law shrines, burial places, chiefs, and all things a chief handled, were, in former days, believed to be rendered sacred. Whatever was "tapu" must not be profaned by the touch of common mortals; in olden days death by execution followed an act of desecration. At the present time, even among educated Maoris, a more or less shadowy belief lingers that "tapu" is not yet bereft of its awful potency. For example, the decaying wood of an empty, unclaimed wharē, or house, would not be interfered with by a strange Maori. The wharē might be "tapu," and its desecration might bring disease and death.

A striking illustration of the present-day belief in "tapu" on the part of the Maoris is provided by the settlement, or village, of Maungakawa, near Cambridge, in the North Island, which place was once the home of Tawhiao, King of the Maoris. Grey, bleached wharēs are scattered about on the hilltop, grass and wild-flowers grow close to door and window. Roofs are falling in, gaps are appearing in the raupo walls. Within the buildings lie household goods, articles of clothing, mats: everything remains as it was when, sixteen years ago, the owners were called upon to go forth and seek a home elsewhere. For Tawhiao had died and the tohungas, or priests, had laid tapu on the king's council hall and on his house, on the dwellings of the people, and on all the lands of Maungakawa. Since that day, whatever curiosity irreverent pakehas (whites) may have exhibited, it is safe to say that few, or no, Maoris have entered within the now sacred circle of the one-time royal settlement. The late king's wharē stands apart from the other houses, and is rendered conspicuous by its large size and the wealth of Maori carving with which it is ornamented. Rumour states that Tawhiao's body lies beneath the floor of the wharē. Another, and a more probable, story is that, after its interment with Christian rites

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within the Huntly churchyard, the body, in accordance with Maori custom, was exhumed. Following the practice of their ancestors the Maoris would remove the flesh from the great rangatira's bones with pieces of sharp obsidian, and the bones would be painted dark red, tied together with ropes of grass, and deposited in a secret cave somewhere among the neighbouring mountains.

At the large and the principal native settlement of Mataatua, in the Urewera, is a much carved temple, or praying house, which was built by the Hauhaus to the memory of their great warrior, priest, and prophet, Te Kooti. Until recently it was altogether tapu; now, for some reason not clearly understood by the writer, tapu seems to have been partially removed. But visitors, before entering, pakehas not excepted, are compelled to leave outside such mundane articles as purses, tobacco, knives and matches. The presence of food within the building would still be considered a desecration. This temple, or wharētapu, is considered by authorities to be probably the most interesting specimen of Maori decorative architecture in New Zealand. Surmounting the entrance to the temple, which is always spoken of by the Maoris as "Te Whai-a-te-Motu," is a carved head or "teko-teko," dark red in colour, its large, shell-made eyes aglitter. This represents the warrior-chief, Te Unu-ariki, who, more than a hundred years ago, was the most prominent brave in Tuhoeland. Below the "teko-teko," carved and painted, appears a monster, half-dog, half-crocodile. This effigy is that of Tangaroa, the enchanted dog of Taneatua, a chief who, six hundred years ago, reached the Bay of Plenty in the famous canoe, Mataatua. The dog, according to Maori belief, was left by Taneatua at a small lake among the Urewera mountains, where it can still be seen as a "tipua," or demon. Within the temple are many carved images of entirely fabulous creatures, and numerous extremely grotesque statues of the tribes' ancestral heroes.

Ancient Egypt is recalled by a visit to an old, well-preserved, highly-decorated Maori settlement. In the painted and sculptured scenes depicted on Egyptian tombs the kings stand out boldly in the foreground, and their tall figures tower above all else. So it is in Maoriland. The greatness of the chief is represented by his colossal size. Rudely drawn and glaringly coloured canoes are favourite subjects with the Maori artist. Every canoe must have its chief, and he is shown usually four times taller than the others. Egyptian-like ideas, as well as Grecian, still prevail as to the close connection between gods and men, as between men and trees, and certain lowly animals. Tane, the god of the forests, yearly sheds his blood when the rata blooms tinge the sombre woods and tree-covered hills with glowing crimson. For misdeeds, and by the evil agency of tohungas, men and women have been transformed into rocks, into trees, and into lizards. The Maoris claim to have descended from different objects, animate and inanimate. High-born individuals, that is chiefs or rangatiras, favour the genealogy that gives them the tuatara lizards for ancestors. And that belief is by no means extinct at the present time. Not many months ago, in the New Zealand Native Land Court, a Maori title to lands was in question. The appellant, who founded his hereditary claim on remote antiquity, proceeded to recite his list of distinguished forefathers. There was Te So-and-So, the original holder of the land, whose son was Te So-and-So, whose son was Te So-and-So——"Hold on," called the judge, as the list was being rolled out—he knew the Maori ways—"These names you have been giving us, are they the names of men?" "Oh no," replied the Maori, "not come to men yet. The names I give you are of tuataras." "I thought so," responded the judge, "better skip the lizards and come to the men."

"Muru" is another Maori law descended from remote antiquity. It means an act of revenge, or of justice, carried out by those who deem themselves wronged, against the wrongdoer, real or imaginary. A man or woman commits what is considered an offence against an individual, a family, or a tribe, whereupon all available members of that tribe, who may be joined by friends, swoop down upon the offender, and carry off all his or her possessions: everything is taken that can be transported or is capable of walking. A frequent cause of muru was, and is, domestic infelicity. That the muru-ing party was frequently of considerable dimensions is seen from its name—taua muru, which signifies "a hostile, plundering expedition." A few months ago, on the Bay of Plenty, the present writer witnessed a process of muru-ing. A young man, recently married and well off, as the average Maori would consider, disappeared, and with him the unmarried daughter of a neighbour. The delinquent left behind him, not everything, but sufficient to satisfy the inevitable taua muru. Had he removed all his property the friends of his discarded wife would have been justified—in their own eyes—in raiding his relatives. Two days after the elopement the taua muru arrived at the home which was about to be broken up. The forsaken wife was there, by no means broken-hearted. Indeed it was a noisy, jubilant, jovial company of marauders. The greater part of a long morning was occupied in collecting the plunder—namely, bags of maize, quantities of kumeras (sweet potatoes), rewi (potatoes), and corn; horses, dogs, pigs and poultry, household furniture and utensils. It was a happy procession which wended its way towards the west that evening; every member of the company, from the oldest to the youngest, had secured a more or less valuable souvenir of the day's interesting proceedings. The writer has been informed of a remarkable cause of muru-ing which came to light two years ago, also on the Bay of Plenty. A young child, for health reasons, was brought from Tuhoeland to be nursed by relatives on the coast. The child died, and its father and his friends unflinchingly harried the hospitable coast-folks.

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THE FACE OF THE SKY FOR FEBRUARY.

By W. SHACKLETON, F.R.A.S., A.R.C.S.

THE SUN.—On the 1st the Sun rises at 7.42 and sets at 4.46; on the 28th he rises at 6.52 and sets at 5.35. The equation of time is nearly 14 minutes throughout the month, the Sun being later than the clock; this makes the afternoons longer than the mornings. Sunspots may occasionally be observed, though they are not very numerous. The positions of the Sun's axis, centre of disc, and heliographic longitude are given below:—

Date.	Axis inclined from N. point.	Centre of Disc S. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
Jan. 31 ...	11° 40′W	6° 1′	259° 28′
Feb. 5 ...	13° 41′W	6° 20′	193° 38′
,, 10 ...	15° 36′W	6° 38′	127° 48′
,, 15 ...	17° 22′W	6° 52′	61° 58′
,, 20 ...	18° 59′W	7° 2′	356° 7′
,, 25 ...	20° 29′W	7° 10′	290° 16′
Mar. 2	21° 48′W	7° 14′	224° 24′
,, 7 ...	22° 58′W	7° 15′	158° 32′

Towards the end of February and early March the Zodiacal Light should be looked for in the West, immediately after Sunset.

THE MOON:—

Date.	Phases.	H. M.
Feb. 6 ...	☽ First Quarter	3 28 p.m.
,, 13 ...	○ Full Moon	10 38 a.m.
,, 21 ...	☾ Last Quarter	3 44 a.m.
Mar. 1 ...	● New Moon	0 31 a.m.
,, 7 ...	☽ First Quarter	11 2 p.m.
Feb. 9 ...	Perigee	4 54 p.m.
,, 21 ...	Apogee	4 30 p.m.
Mar. 6 ...	Perigee	4 30 p.m.

OCCULTATIONS.—The following are the principal occultations visible in this country:—

Date.	Star's Name	Magnitude.	Disappearance.		Reappearance.	
			Mean Time.	Angle from N. point. E.	Mean Time.	Angle from N. point. E.
			p.m.		p.m.	
Feb. 7	A^1 Tauri ...	4·5	5.26	8°	6.4	304°
,, 11	λ Cancri ...	5·9	5.50	102°	6.53	272°
,, 13	42 Leonis ...	6·1	8.57	103°	10.5	306°
,, 15	*b* Virginis ...	5·2	8.24	89°	9.17	327°
			a.m.		a.m.	
,, 21	δ Scorpii ...	2·5	2.4	39°	2.20	14°
,, 21	B.A.C. 5335 ...	5·7	5.47	134°	7.5	269°
			p.m.		a.m.	
Mar. 6	A^1 Tauri ...	4·5	11.57	71°	0.47	270°

THE PLANETS.

MERCURY:—

Date.	Right Ascension.	Declination.
	h. m.	
Feb. 1 ...	19 10	S 21° 26′
,, 11 ...	20 0	21° 7′
,, 21 ...	20 59	18° 48′
Mar. 3 ..	22 2	S 14° 18′

Mercury is a morning star throughout the month, rising in the S.E. by E. at about 6.30 a.m. The planet is at greatest Westerly elongation of 25° 17′ on February 2nd; the elongation is moderately favourable and about this date one has the best chance of seeing this elusive planet, though it will be necessary to observe before 7 a.m.

VENUS:—

Date.	Right Ascension.	Declination.
	h. m.	
Feb. 1 ..	22 1	S 13° 46′
,, 11 ..	22 48	9° 11′
,, 21 ...	23 34	S 4° 11′
Mar. 3 ...	0 19	N 1° 0′

Venus is an evening star in Virgo, setting about two hours after the Sun towards the end of the month, and thus observable for a short time in the West, immediately after Sunset. In the telescope the planet appears nearly at "full," 0·97 of the disc being illuminated, with an apparent diameter of 10″.

MARS:—

Date.	Right Ascension.	Declination.
	h. m.	
Feb. 1 ...	18 2	S 23° 49′
,, 11 ...	18 33	23° 44′
,, 21 ..	19 5	23° 15′
Mar. 3 ...	19 37	S 22° 22′

Mars is visible in the mornings, rising about 5.15 a.m. near the middle of February. The planet is situated in Sagittarius, but is rather an inconspicuous object and ill-suited for observing through the telescope, the apparent diameter of the disc being less than 5″.

JUPITER:—

Date.	Right Ascension.	Declination.
	h. m.	
Feb. 1 ...	14 45	S 14° 42′
,, 11 ...	14 48	14° 53′
,, 21 ...	14 50	14° 58′
Mar. 3 ...	14 50	S 14° 58′

Jupiter rises in the E.S.E. before midnight at the end of the month; on the 1st February he rises at 1.20 a.m., and on the 1st March at 11.35 p.m. The planet, with his bright moons, dark equatorial belts and spots, is an interesting object even in small telescopes. He is in quadrature on the 3rd February, and at the stationary point on the 1st March. The equatorial diameter of the planet is 38″, whilst the polar diameter is 2″·5 smaller. This polar flattening is readily observed in telescopes powerful enough to see the belts, but the satellites may be seen in small telescopes, such as deer-stalkers of about 1¼ inches aperture, or even in a good pair of prismatic binoculars magnifying eight times. The Moon appears near the planet on the 19th.

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SATURN :—

Date.	Right Ascension.	Declination.
	h. m.	
Feb. 1 ...	1 57	N 9° 26′
,, 16 ...	2 1	9° 50′
Mar. 3 ...	2 6	N 10° 20′

Saturn is getting more to the West, but is observable throughout the month till 10 p.m.

The planet is a conspicuous object in the South-West portion of the sky, and appears in Pisces about ten degrees South of α Arietis. Observed in the telescope, the ring appears open fairly wide, since we are looking on the Southern surface at an angle of 17°. The apparent diameters of the outer major and minor axes of the ring are 40″ and 12″ respectively, whilst the diameter of the ball is 16″. In the telescope, in addition to the ring, the belts on the planet's disc—although not so conspicuous as those on Jupiter—may easily be discerned. The Moon appears near the planet on the 5th.

URANUS :—

Date.	Right Ascension.	Declination.
	h. m. s.	
Feb. 1 .	19 53 20	S 21° 24′ 3″
Mar. 1 ...	19 59 36	S 21° 7′ 15″

Uranus is a morning star, rising about 6.30 a.m. near the middle of the month, and for all practical purposes is unobservable.

NEPTUNE :—

Date.	Right Ascension.	Declination.
	h. m. s.	
Feb. 1 ...	7 24 28	N 21° 23′ 1″
Mar. 1 ..	7 21 56	N 21° 28′ 45″

Neptune is situated in Gemini, about three-and-a-half degrees South-East of the star δ Geminorum. The planet is on the meridian about 9.40 p.m. near the middle of the month, and is practically above the horizon the whole night throughout the month. He is difficult to detect except in large telescopes, but he may be identified in small telescopes by his relative motion if successive observations are made some few days apart.

METEOR SHOWERS :—

Date.	Radiant.		Near to	Characteristics
	R.A.	Dec.		
	h. m.			
Feb. 5–10 .	5 0	+41°	η Aurigae	Slow ; bright.
,, 15 ...	15 44	+11°	α Serpentis	Swift ; streaks
.. 20 .	12 4	+34°	Cor Caroli	Swift ; bright.

Minima of Algol occur on the 19th at 8.38 p.m., and on the 22nd at 5.27 p.m. The period is $2^d\ 20^h\ 49^m$ from which data other minima may be calculated.

Mira (ο Ceti) is due at minimum on February 26th, its magnitude being about 8·5.

Double Stars.—*Castor*, separation 5″·6, mags. 2·7, 3·7. Excellent object for small telescopes. The brightest pair to be observed in this country; can always be relied upon as a good show object.

κ Geminorum, separation 6″·3, mags. 4, 8·5; very pretty double.

ζ Cancri, separation 0″·9, 5″·2, mags. 5·5, 6·5, 7·5; with small telescopes the wider component is readily seen.

ν Draconis, separation 61″·7, mags. 4·6, 4·6; a pretty and easy double; can be separated by observing with a pair of opera glasses.

CLUSTERS.—M 44, the Praesepe in Cancer, visible to the naked eye as a nebulous patch, best seen and easily resolvable with a pair of opera or field glasses. On account of the scattered nature of the group the cluster effect is lost when observed with a telescope unless very low powers be employed. Situated about midway, and a little to the West of, the line joining α and δ Cancri.

THE ASSOCIATION OF PUBLIC SCHOOL SCIENCE MASTERS

AT a general meeting held at the London Day Training College, on January 11th, Sir Ray Lankester, F.R.S., the President of the Association of Public School Science Masters, gave an address upon "Compulsory Science *versus* Compulsory Greek." So far as his own experience went, he condemned public schools. At the one which he himself attended, he maintained that he learnt nothing, though he was at the top of his various forms, and finished as the head boy. He thought that all the public schools should be day schools, that no master should be allowed to keep a boarding-house, being paid sufficiently well to make it unnecessary, and that only the very ablest teachers should be employed. He urged that the boy should have home surroundings, plenty of time to himself, and a place in which he could work undisturbed. Sir Ray Lankester brought many arguments to bear against compulsory Greek, and among the strongest of these were the following:—That although Latin had in times gone by been a necessity to the educated man, and was required if the scientific progress of the day was to be followed, the intention of learning Greek was to be able to read the works of the Greek authors in their own tongue. Many of the translations which exist render this unnecessary, and as an answer to the contention that Greek should be studied because classical men appreciated the Greek ideals, a translation was given of Aristotle's description of what constituted a good education. This coincided almost exactly with what a scientific man would lay down to-day.

In conclusion, a detailed scheme of work beginning with what Sir Ray Lankester called Equipment Studies, was laid down, and the way in which it could be carried out with efficiency was outlined. Among the Equipment Studies were these, in the order in which they were given:—English language, Latin, French, German, and Arithmetic.

After the Presidential address, Mr. A. Vassall (Harrow) dealt with the education of a medical student. He pointed out some common misunderstandings with regard to the powers and functions of the General Medical Council, and thought that if there was a movement in favour of one central qualifying body, the latter would probably be the Council in question. "The Association," he said, "must watch that this does not happen without the Head-masters' Conference being aware of it, otherwise, when it was too late, public schools would find themselves burdened with yet one more syllabus forced upon them as necessary for a good general education."

On the second day of the meeting, among the subjects down for discussion were the teaching of English in connection with science lessons, introduced by Mr. W. D. Eggar (Eton), and the use of the wave theory and of rays in teaching light.

XUM

NOTES.

ASTRONOMY.

By F. A. Bellamy, M.A., F.R.A.S.

THE ASTRONOMICAL SOCIETY OF BARCELONA.—The first annual meeting of this Society was held on the 8th December last, when, in accordance with the rules, the new president and executive council were elected. Interesting addresses were delivered by the retiring President on the progress of astronomical science during the year 1910, and by the Secretary on the development of the Society since its foundation. The inaugural meeting of the Society was held on the 30th January, 1910, at the University of Barcelona, as a result of the labours of Don Salvador Raurich, who had been carrying out valuable educational work in the city by means of popular articles on astronomical and allied subjects, contributed to the columns of *Las Noticias*, a well-known Barcelona journal. There were present at the inaugural meeting ninety persons from all branches of Society, including several professors of science from neighbouring colleges. Dr. Estéban Terradas, Professor of Science in the University of Barcelona, was elected first President, and a strong executive council was formed. In April, King Alphonso became a life member, and was elected Honorary President. In July, the first number of the monthly Bulletin was published, and this is now exchanged with all the leading societies and observatories. In the following month a prize medal was coined from the designs of Don Dionysius Renart. At the present time the membership numbers two hundred-and-thirty, and as a result of the first year's work the Society finds itself with a bank balance of £80, after paying all expenses. In the future it is intended to devote the accumulated funds of the Society to the erection and equipment of an observatory, where members may meet regularly, in a social way, for practical observation and the informal discussion of questions of astronomical interest. In the meantime, arrangements have been made with those members possessing private observatories to allow other members access thereto on specified occasions.

During the year eight lectures on astronomical subjects have been delivered in the Grand Saloon of the University of Barcelona, and numerous addresses on a smaller scale were given on practical spectroscopy and general astronomy in the private observatories of certain members.

The following is a list of the officers of the Society for the year 1911:—

President: Professor Eduardo Fontseré, D.Sc., Chief of the Time Service of Barcelona.
Vice-Presidents: Professor Luis Canalda and Don Ferdinand Tallada.
Secretary: Don Salvador Raurich.
Vice-Secretary: Don A. Pulvé.
Treasurer: Professor M. Font y Torné, M.D.
Other Members of the Council: Professor Ignacio Tarazona, Professor of Astronomy in the University of Valencia; Dr. Enrique Calvet; Don Jose Subiranas, and Don Juan Mercadal.

The address of the Secretary is Diagonal, 462, Barcelona, where all communications should be addressed. The Society is entering upon its second year of activity with bright prospects, and is very successfully cultivating a taste for astronomical study among all classes in Spain.

William Porthouse.

PRELIMINARY GENERAL CATALOGUE OF 6188 STARS.—The publication of this catalogue is the most important piece of computational work of its kind since the British Association Catalogue of 8377 Stars was compiled and published under the direction of F. Baily, about sixty years ago. Both these works differ from most other star catalogues in that they are not composed of observations made with one instrument or at one observatory, but the observations are collected from the best star-catalogues and records mostly already published at various institutions.

The main principle pervading this work of Professor Boss is to determine accurate positions for a definite epoch, 1900·0,—we heartily welcome the adoption in meridian catalogues of such very convenient epochs as 1900, 1925, 1950, and so on, rather than the usual plan of taking the mean epoch of the observations, so any odd year may result,—of all stars observed that indicate a proper motion of 10″ a century, together with a number of other stars of less motion included for various reasons: the computation of the motions of all these stars became the primary aim. Compiling these results in catalogue form was considered the best way of exhibiting them.

The stars included in these 6188 are chiefly stars visible without a telescope, therefore of the sixth magnitude and brighter; there are 4030 of these, 1919 north stars, and 2111 south stars; of the 2158 remaining, all fainter than the sixth magnitude, most of them are stars observed by James Bradley about one hundred and fifty years ago.

A preliminary piece of work of fundamental importance was the preparation and publication of a Catalogue of 627 Principal Standard Stars. In that were described the methods employed, and upon those star places the present catalogue of 6188 stars was based. During the progress of the work it became manifest that a great extension of the scope of the work upon a "general catalogue" was desirable. Certain materials for a catalogue of 25000 stars, to about the seventh magnitude, were available; but to include all these additional stars would require re-observation of a great number; besides, the increased time and expense required would be very great. The Carnegie Institution of Washington having agreed to provide the money for this greater proposal, Professor Boss decided to complete and publish the smaller work to the sixth magnitude, much on the lines as planned, depending upon other observatories' work, and to treat the greater catalogue as an independent piece of research work, which it certainly will be, as all the 25000 stars will be specially re-observed at two places in order to produce more homogeneous results.

A list of catalogues from 1755–1900, which have been used in the compilation, is given in the Introduction. It should be noticed that, differing from the usual practice, the correction for eliminating the effects of the magnitude-equation has been included in the right ascensions at the rate of s·008 per magnitude (on Pogson's scale of log. ratio, ·4).

The magnitudes have been taken from Chandler's Normal Uranometry (in MS. only), wherein the light ratio ·36 is used instead of Pogson's ·4, hitherto almost universally used by astronomers; it is to be presumed that there is sufficient reason in that unpublished work for this change, otherwise the change is to be regretted. The result is that a magnitude-equation determined in conformity with the Pogson scale (log. ·4) should be multiplied by 0·9 in order to reduce it to the scale of this catalogue, or *vice versa*.

A large amount of valuable information is given concisely in the Introduction, and there are three appendices. Appendix I contains ephemerides of Polar stars between 1900 and 1925. Appendix II contains important notes upon certain special stars, mostly binaries. Appendix III, pages 279–345, has involved almost as much work as the actual catalogue, and is of little less importance. It gives concisely the systematic corrections to each catalogue used, the corrections used for magnitude-equation, and the value or weights given to each catalogue. Altogether, it is a most valuable contribution to accurate astronomy, as distinct from the speculative side; it is beautifully printed, and forms Publication No. 115 of the Carnegie Institution of Washington. Professor Boss acknowledges his indebtedness to that Institution, to Dr. S. C. Chandler, to Mr. A. J. Roy, Mr. W. B. Varnum, Miss B. Benway, and Mr. B. Boss, for their zeal and help in the work.

F. A. B.

XUM

VARIABLE OR NOVA LACERTAE (ESPIN).—The beginning and end of the year 1910 were characterized by important astronomical discoveries; the beginning was by the Daylight comet, the end by a bright New star, which is appropriate at this particular season of Epiphany.

"Kiel 6.55 p.m., received at Oxford 7.33 p.m., December 31st, 1910.

"To University Observatory, Oxford.

"Nova Lacertae Espin Tow Law 30080 Dezember 07359 Greenwich 33802 03744 72239 47224 Helle Linien."

Thus runs the telegram received by the subscribers to the Central Office for Astronomical Telegrams conducted by Dr. Kobold at Kiel. Its meaning is that the Rev. T. E. Espin, M.A., F.R.A.S., formerly of Exeter College, Oxford, and now the Rector at Wolsingham, Tow Law, near Darlington, by assiduously watching the sky and examining the stars for duplicity and variability, was able to detect the appearance of a bright star of about the seventh magnitude near the edge of the constellation Lacerta, towards Cepheus, at R.A. $22^h\ 32^m\ 10^s\ 15'\ 21''+52°$ (1911), and in the Milky Way, about 6 p.m., on December 30th. Reference to maps failed to show any star in that position, and upon examination with a spectroscope, bright lines were noticed in such positions as indicated the star to be a new one, or one variable in magnitude. The evening of December 31st was very cloudy. At Oxford, on January 1st, two photographs of the region were taken with four exposures of a few minutes each, and the results of the measurement of one of these plates were communicated to the Royal Astronomical Society's meeting on January 13th, and will be published in the *Monthly Notices* in February. Photometric and eye estimations of its magnitude have been made by Mr. Espin, and at the observatories at Greenwich, Cambridge, Oxford (both observatories), Harvard College (U.S.A.); the magnitude was made out to be between 7·0 and 8·0, or one-and-a-half magnitudes brighter than the star near it. Various observers have noted it as "red"; the writer has not yet been able to make it deeper than "orange," and to him it appears to have nothing of the "Hind's crimson," R. or S. Cephei hue about it. The magnitudes deduced from photographic plates, however, do not fit in with the general ideas of chemical action, colour, and photographic results; for, if the colour be red or orange and less actinic to the sensitive film of a monochromatic plate (with emulsion such as is generally in use for hand-camera and extra-rapid work), one would expect to get a smaller image of it on the photograph than of a normal star, both being determined by photometric or visual observation to be of the same magnitude, say seven. But the photographs appear to give the magnitude on January 1st and 2nd as 6·7 or 6·6, or about two-thirds of a magnitude brighter than by other methods. During the first part of January the star changed or lost little, if any, of its brightness.

Mr. F. W. Dyson, the Astronomer-Royal, has received information from the Harvard College Observatory that the new star was visible on photographs exposed there on November 23rd, 1910, when its magnitude was determined to be equal to 9 Lacertae, or 5·0 photographically, and, therefore, quite visible without optical aid. The interesting feature in the examination of the Harvard store of photographs, going back many years, is that, on November 19th the star was not visible, *i.e.*, it was probably fainter than the eleventh magnitude, if at all visible in the sky; it was again photographed on December 7th, but, in spite of the large number of telescopes, photographs, and keen observers searching the sky, this naked-eye star was not detected until December 30th, by Mr. Espin.

Though some are disposed to consider the discovery to be merely that of a variable, because rumours have been current that Dr. Max Wolf has photographs, taken nearly twenty years ago, which show a faint star in the position of the Nova, —but we must wait for accurate measures, before accepting this information—there is plenty of evidence for us to consider it to be as much a new star as others. The immense and nominally instantaneous brightening up by eight, ten, or more magnitudes—as in the most prominent cases of T. Coronae (1868), Nova Andromedae (1885), Nova Aurigae (1892), Nova Persei (1901), and Nova Geminorum (1903)—classify these *Novae* as being of a different order from all known variable stars, though their spectra may be similar.

Two questions arise and present themselves for astronomers to solve, now that thousands of photographs, taken during the last thirty years, are available for reference. When is a *Nova* not a *Nova*? And who is to be entitled to the credit of the discovery in such cases as *Nova* Geminorum and the star which is the subject of this note? Surely not the one who first saw or photographed it, but the one who first drew the attention of the astronomical world to it.

F. A. B.

THE PRESENT STATE OF VARIABLE STAR WORK (II).—For the sake of convenience the following survey of variable star work has been arranged under the heading of countries, taken approximately in the order of their respective importance as regards this matter. I have made no attempt to write an historical sketch and, therefore, have confined myself essentially to present facts. As it may be easily understood, "absolute" completeness in such a work is difficult to attain: many astronomers have made purely accidental discoveries of variable stars in the course of other duties—such as observations of planets, comets, and double stars, zone observations, measures and comparisons of celestial photographs—without being really interested in this branch of astronomy, and it could be hardly possible to include their names here. I am satisfied, however, that no essential fact has been overlooked in the following.

GERMANY.—If the height of scientific activity resides in care, spirit of enterprise, continuity, abundance and accuracy of bibliographical sources and especially "thoroughness," rather than in multiplicity of discoveries, one must admit that German astronomers, following the glorious steps of their great Argelander, the initiator of the "science" of variable stars, always took the lead in this branch of astronomy.

A good deal of this result, in modern years, is undoubtedly due to the vivid interest shown in stellar photometry by the "Astronomische Gesellschaft," an international association of (principally professional German, Austrian, Scandinavian and Russian) astronomers, established in Leipzig in 1865. The "A.G.," as it is generally named for the sake of brevity, whose star catalogues are well known everywhere, controls three organizations of importance connected with our special subject.

(1) A "Committee on Variable Stars," at present composed of Professor N. C. Dunér, director of the University Observatory of Upsala (Sweden), Professor Dr. Ernst Hartwig, director of the Remeis Observatory in Bamberg (Bavaria), and Professor Dr. G. Müller, chief astronomer at the Royal Astrophysical Observatory of Potsdam (Prussia). When, in 1901 (See *Astronomical Journal*, Nos. 491–492 and Nos. 505–506), Mr. Seth C. Chandler, of Boston, to whom I will refer afterwards, declared that he was going to give up the important and strenuous task of collecting all available information on variable stars, and cease to assign definitive names to those whose elements were sufficiently known, a work which he had carried on for years with a great skill, the A.G. Committee on Variable Stars which, at the time, comprised also the Dutch Professor Oudemans, since deceased, at once took over the matter and has directed it ever since with a great exactness, Professor Müller especially taking a great share in the work. The Committee has made special and very wise rules (fully explained in *Astronomische Nachrichten* 171, 347) for the admission of suspected variable stars among the number of those to which definitive letters are affixed, the principal of them being that the range of light variation ought to be at least half a magnitude, that the character of this variation must be, at least roughly, indicated, and that it must have been confirmed by at least one other observer than the discoverer. Save some critical views uttered by that other well-known authority, Professor E. C. Pickering (See *Annals of Harvard College Observatory*, Vol. lv., page 87), and which serve only to demonstrate the fact that no human work

can reach perfection, the verdicts of the Committee have always met with the approval of the astronomical world, and received unanimous praise.

Once a year, generally in the month of November or so, the Committee publishes, in the *Astronomische Nachrichten*, a list of lettered variables, giving in tabular form, their name, provisional number, position for 1855.0 and 1900.0, value of precession, magnitudes at maximum and minimum, and indication whether these magnitudes are visual or photographical. This list is supplemented by notes giving references to catalogues ("Bonner Durchmusterung," or "A.G." numbers), indicating the name of the discoverer and "supporter," and giving a short historical sketch, with elements, colour, and other notes.

(2) The *Astronomische Nachrichten* (*A.N.*), the leading astronomical paper of the world, is published at Kiel (Schleswig-Holstein), at the rate of one or two numbers, generally of eight pages (or sixteen "columns" as they are numbered) a week, twenty-four numbers forming one volume. The character of this paper is thoroughly international and, though many papers are printed in the German language, French, English, Italian, Spanish, and even Latin memoirs are not uncommon. The *Astronomische Nachrichten*, founded by H. C. Schumacher, in 1821, September, and therefore the oldest amongst astronomical journals, is about to publish its one hundred and eighty-seventh volume (commencing with No. 4465, issued 1911, January 12th), and is under the editorship of Professor Dr. Hermann Kobold, astronomer at the Observatory of Kiel's University, who also directs the *Centralstelle* for the centralization and circulation in Europe of astronomical news. The collection of this paper includes also seventeen more or less extensive complementary numbers or *Ergänzungshefte* and six general tables of contents, a seventh being in course of preparation, as well as reprints of some old volumes.

The *Astronomische Nachrichten* contains the greatest part of variable star information and has, for a long time, been the medium through which new discoveries of these objects are announced to the world. In order to avoid confusion and to permit easy references, Professor Kreutz, the fourth editor of the paper (the first was Schumacher), decided, in 1900, to affix a "provisional number" to new variables, pending their definitive lettering by the "A.G." Committee. This series of numbers is begun again every year, from No. 1, the name of the year being affixed to the number. So, for example,

BD+7°929=47.1910 Orionis=RT Orionis.

This is a similar method to that followed for new asteroïds, save that a reverse system is in use; newly-discovered small planets receive a double letter with the year prefixed, and are afterwards numbered and named.

(3) Some years ago the "Astronomische Gesellschaft," represented by its committee on variables, decided to compile and publish a great catalogue of these objects. As will be seen afterwards, works of this kind have been planned and partly printed elsewhere, but it may be confidently assumed that the bibliographical task now undertaken in Germany will go far beyond all that has been done till to-day, and will form a standard work, whose value, as it approximates to completeness, can hardly be overrated.

The catalogue will be divided in four great sections:—(*a*) Variable stars; (*b*) Suspected variable stars; (*c*) Variable stars in clusters; (*d*) New or temporary stars; dealing with one thousand objects. Other somewhat abridged monographs will deal with newly-discovered variables, for which the available material of observation is less abundant. The work will give for each variable the "complete" bibliographical sources and references, and a thorough discussion of all published (and, in many cases, unpublished) data. It will not include however, some well-known variables on which complete monographs have already been published, such as o Mira Ceti (Guthnick), χ Cygni (Rosenberg), δ Librae (Kron), R Coronae (Ludendorf) and U Geminorum (van der Bilt).

The discussion of this formidable material, always kept up to date, has been divided among a number of fellow-workers. At the time of writing, the MSS. for seven hundred stars is ready, two hundred are under discussion, and one hundred are still in abeyance. In the course of its twenty-third meeting, recently held in Breslau (see "KNOWLEDGE," 1910, November and December), the Society voted a sum of 1,000 marks (£50) towards the continuation of the work, and 10,000 marks (£500) towards the cost of printing the first part, which may be expected to appear in the course of the present year.

FELIX DE ROY,
Honorary Secretary "Société d'Astronomie d'Anvers."

(*To be continued.*)

BOTANY.

By PROFESSOR F. CAVERS, D.Sc.

EOCENE FLORAS.—In a recent paper on "An Eocene Flora in Georgia, and the Indicated Physical Conditions," Berry (*Bot. Gaz.*, vol. 50, 1910), draws an interesting comparison between the Eocene floras of Europe and North America. The Middle Eocene floras of North America, like those of Europe, show distinctly tropical characters, which are absent in the earlier or Lower Eocene. These characters first become marked in the fruits from the London Clay and the leaves from Alum Bay, and in corresponding deposits on the Continent. These floras show much closer affinities with the modern floras of Malaysia and tropical America than with those of Australia—the supposed Australian affinities of the Eocene floras may now be regarded as an exploded myth. The Eocene genus *Nipadites* corresponds exactly with the modern Palm genus *Nipa*, which inhabits the tidal waters of the Indian Ocean, and ranges from India, through the Malay Archipelago, to the Philippines. The *Nipa* swamps of the Eocene period ranged northwards in Europe to southern England, and though *Nipadites* does not occur (so far as known) in the Eocene of America, the latter shows various forms, either identical with, or allied to, the plants associated with *Nipadites* in the Eocene of Europe, including various tropical Ferns. The existing flora of Florida, the Bahamas and Bermuda contains a large element which has been derived in comparatively recent geological times from the south, but the main elements of these modern floras were already in existence in the Middle Eocene, if not earlier. There is abundant evidence that nearly all modern plant families, excepting such specialised forms as the Orchidaceae among Monocotyledons and the Compositae and their allies among Dicotyledons, were at one time more widely distributed than they are at present, and that the details of modern geographical distribution represent in a less degree the interchange of types between different areas than they do the greater or less degree of segregation of descendants of forms once spread over much wider areas. The strictly modern movement of the subtropical flora along the course of the Gulf Stream has been from the south, northward, as the various coral islands of the Bahamas became evolved. This dispersal was preceded by a similar spread of the tropical flora on a much more extended scale during the early Tertiary.

AFFINITIES OF CACTACEAE.—The Cactaceae have attracted a large amount of attention recently. A special German journal has been founded to deal exclusively with this family of plants, and some interesting observations and speculations have been made by various writers regarding the affinities of the family and its position in the natural system. The Cactaceae have for long been regarded as an isolated group of obscure affinities, and in different systems of classification they occupy very various positions. Although the Cactaceae are highly specialised as regards their vegetative characters, there are many features in their floral structure that indicate affinities with the cohort Ranales, which includes the orders Nymphaeaceae (Water-lilies), Magnoliaceae (Tulip-tree, and so on), and Ranunculaceae, besides others. The most striking of these "Ranalian" characters are: (1) the numerous spirally arranged sepals, petals, stamens, and carpels; (2) the occurrence in some cases of a gradual transition from sepals to petals; (3) the insertion in some cases of the sepals and petals on the outer surface of a receptacle cup in which the carpels are embedded. There is

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an especially striking similarity between the flowers of such Cacti as *Pilocereus* and such Nymphaeaceae as *Victoria* and *Euryale*. The suggestion of a "Ranalian" ancestry for the Cacti, based on the structure of the flowers, is greatly strengthened by the recent work of Miss de Fraine (*Ann. Bot.*, 1910) on the structure of the transition region between stem and root in the seedlings of various members of this order. It was found that in those Cacti which have the least modified seedlings—those in which we should expect to find that ancestral characters would be retained—the same type of transition of the vascular bundle system occurs as in certain Ranunculaceae. Miss Sargant (*Ann. Bot.*, 1900) showed that this particular type of transition structure pointed to the origin of the Monocotyledons from Dicotyledons allied to Ranunculaceae.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (Oxon.), F.I.C.

STERILISATION OF WATER BY MEANS OF ULTRA-VIOLET RAYS.—The use of ultra-violet rays for the effective sterilisation of large quantities of water has been made the subject of several recent patents, and processes based upon the principle have been adopted in many places. It has been demonstrated by Messrs. Urbain, Scal and Feige, (*Comptes Rend.*, 1910, CLI., 770,) that the most important factor in this method of sterilisation is that there should be uniform exposure of the particles of water to the source of light. In some types of apparatus this condition is attained by enclosing the mercury vapour lamp in a box with three quartz sides, round which the water is made to flow in a semi-circular trough in such a way that it moves alternately towards and away from the lamp, which forms the centre of the semi-circle. Again, in the apparatus constructed by Urbain and his collaborators, the water is made to circulate in a spiral within a cylinder about two-and-a-half yards in diameter, the opening into which is concentric with its axis. The water being forced into this cylinder at a tangent, whorls round so as to leave a nearly vertical cavity in the centre, and within this is suspended the lamp. Under these conditions, the maximum distance of the water from the source of light is about forty-two inches, and the minimum distance about three-and-a-half inches, while the period of exposure is about three minutes. The positive electrode of the lamp is composed of aluminium, coated with a thin layer of iron, while the negative electrode consists of carbon. The yield of sterilised water obtained from an apparatus of this kind ranges from ten to fifty cubic metres per hour. the average quantity being about twenty metres. A sterilising plant based upon this principle has been erected at Neuilly-sur-Marne, and gives a supply of sufficiently sterile water at an expenditure of twenty watts per cubic metre.

THE WATER OF GREAT SALT LAKE.—An interesting series of analyses of water from Great Salt Lake is published by Messrs. Ebaugh and MacFarlane (*J. Ind. Eng. Chem.*, 1910, II, 454), showing the variations in the amount of saline constituents during the last forty years. During the four years of drought ending in 1904, the level of the water fell to such an extent that the idea of the lake becoming dry was seriously entertained; but after the succession of wet years since that date, there is more likelihood of the surrounding country becoming flooded. These extremes are reflected in the composition of the water at the different periods, the specific gravity and the total solids showing an enormous decrease since the close of the dry period. Thus, in October, 1903, the water had a specific gravity of 1·2206, and contained 338·36 grammes per litre of total solids, whereas in October, 1909, the specific gravity was 1·1561, and the total solids were only 242·25 grammes per litre. The composition of the water varies at different periods of the year, the proportion of dissolved salts being greater in the autumn.

A NEW METHOD OF PREPARING ARGON.—A rapid method of obtaining large quantities of argon is described by M. G. Claude in a recent issue of the *Comptes Rend.*, (1910, Vol. CLI, 752). Oxygen obtained in the liquefaction of air is used as the source, for it has been found that the chief impurity in the oxygen is argon, the volatility of which is intermediate to that of oxygen and of nitrogen. To separate the argon, which then often exceeds three per cent., the oxygen is absorbed by means of copper, and the nitrogen by magnesium. For this purpose the gas is passed through a red-hot copper tube charged with reduced metallic copper and copper filings, and on leaving this passes through a red-hot iron tube containing magnesium powder. Lastly, it is passed through a tube of silica containing copper oxide to absorb any hydrogen derived from moisture in the oxygen or in the copper. From eight to twelve litres of pure argon may be obtained by means of this apparatus in about two hours, after which the copper becomes spent, and must be regenerated by a current of hydrogen.

THE SOYA BEAN INDUSTRY.—The importance of soya beans as a new commercial product may be gathered from the fact that during the year 1909, upwards of five hundred thousand tons were imported into this country from China, and were utilised in the manufacture of oil and of seed cake for cattle. Prior to 1908 only small consignments had been imported, but the great scarcity of fats and oils required for the manufacture of soap induced the manufacturers to make experiments with every kind of oil, and as soya bean oil was found well suited for the production of soft soaps and, in admixture with other fats, for hard soaps, it speedily established its present position. The beans, which are used in China and Japan in the preparation of soy sauce and other food products, yield, when pressed, about 10 per cent. of a yellow oil, which has weak drying properties and possesses many points of resemblance to cotton seed oil. The oil is used for food in China, and has been tried for the same purpose in this country. Attempts have also been made to employ it in place of linseed oil in the manufacture of paints and linoleum, but its inferior drying properties have prevented its application in this direction. The beans contain about forty per cent. of protein substances and twenty-three per cent. of carbohydrates, and the residue from which the oil has been expressed is thus a valuable feeding stuff. Unsuccessful attempts have been made to acclimatize the soya bean in Germany, but the plant has already been introduced into West Africa and the southern part of North America, with every prospect of success.

GEOLOGY.

By RUSSELL F. GWINNELL, B.Sc,, A.R.C.S., F.G.S.

A CENTRAL AFRICAN GLACIER of Triassic age is dealt with by Messrs. Ball and Shaler in the *Journal of Geology*, November-December, 1910. The glacial features occur in the Lubilache formation of the Belgian Congo (better known as the "Congo Free State"). This formation consists mainly of alternating beds of sandstones and shales of Triassic age. It is concluded from the evidence that a glacier or glaciers pushed in a tongue down the present valley of the Lualaba River; from the fact that large boulders probably dropped by icebergs are found at least two hundred feet above the base of the formation, it is believed that long after the glacier had retreated toward the south, glaciers still existed to the south-east. This glacial epoch must therefore have been of a considerable duration.

The glacial features presented are:—

(1) Striations having the characteristics of glacial striations, on pebbles in the basal conglomerate of this series, indicating morainal origin.

(2) The tongue-like form of the basal beds and the character of this conglomerate, including the size of the boulders, the lack of assortment, the patchy arrangement of the material and the preponderance of boulders of local origin.

(3) Erratic boulders, presumably dropped by icebergs, occurring in shales of this series.

(4) Probable glacial scratches, crescentic gouges and smoothings on the surfaces of older rocks upon which the Lubilache was laid down.

IGNEOUS ROCK COMPOSITION.—Several petrologists have calculated, from large collections of published analyses, the "average composition" of an igneous rock. In some

cases no account is taken of the relative masses of the rocks represented by the analyses, in others these relative masses are reckoned with as far as possible. By the former method the average igneous rock appears to have a composition close to that of many pyroxene andesites and quartz-mica-diorites: in passing it is interesting to note that these are extremely common rock types. By the second method Professor Vogt finds the average rock to be far more acid—with about 74% of silica—and thus corresponding with a granite in this respect. In "An Introduction to Petrology" (1910), Mr. F. P. Mennell tackles the subject by this second method, dealing with the rocks mapped in the neighbourhood of Bulawayo, in Rhodesia. Putting minor rock types into one or other of larger groups, he estimates eleven thousand nine hundred and sixty square miles of igneous rock (assumed to extend one mile vertically downwards) to be made up as follows:—Granite, eleven thousand six hundred and seventy cubic miles; syenite, forty; picrite, two hundred and forty; dolerite and basalt, ten; and the average silica percentage becomes nearly seventy. If this is fairly representative of other large areas of the earth, it would indicate that granite represents the average composition of the igneous rocks.

A somewhat similar problem is attacked by R. A. Daly in "The Average Chemical Composition of Igneous Rock Types" (*Proc. Amer. Acad. Arts and Sciences*, xlv., 1910). The author, using various collections of analyses, calculates the average chemical composition of ninety-eight principal igneous rock types, and incidentally these may be used as a basis for finally calculating the "average igneous rock." The relative uniformity in the soda percentage of the more abundant types is specially noted in its bearing on the origin of oceanic sodium, and therewith, on the problem of the age of the earth. The striking similarity of the average granite analysis to the average analysis of the base (ground mass) in augite andesite, and the equally close resemblance of the average diorite analysis to the arithmetical mean of average basalt and granite, are illustrated.

The same author discusses the "Origin of the Alkaline Rocks" in *Bulletin Geol. Soc. America*, xxi. (1910). It is usually recognised that there are two great branches of igneous rocks—the "alkaline" (rich in soda and potash), corresponding in a general way with the areas of the Atlantic type of coast-line as defined by Suess, and the "sub-alkaline" or "lime-alkaline," corresponding with the Pacific type. In the present paper, Dr. Daly states that no alkaline province can be described as free from sub-alkaline eruptives, especially those of basaltic or granitic types. Emphasis is laid on the indisputable fact that the visible volume of all alkaline rock-bodies is a very minute quantity as compared with the visible volume of sub-alkaline eruptive bodies. An inductive study shows that most alkaline rocks cut thick masses of limestone or other calcareous sediments. This fact suggests the hypothesis that the absorption of carbonate disturbs the chemical equilibrium of sub-alkaline magma in such manner that alkaline fractions are produced by differentiation. Most of the alkaline species are ascribed to the interaction of basaltic magma and limestone (or dolomite), but more acid magma is also sensitive to the solution of carbonate. The hypothesis explains the concentration of alkalies, the desilication shown by the crystallisation of nepheline, leucite, corundum, and so on; the extreme variability of alkaline bodies in mineralogical and chemical composition, the occurrence of such lime-bearing materials as melilite, scapolite, melanite, and so on, and CO_2-bearing minerals, as cancrinite and primary calcite.

Alkaline rocks of exceptional interest are found in Ayrshire, and neighbouring parts of Scotland. A preliminary account of some of the types is supplied by Mr. G. W. Tyrrell (*Trans. Geol. Soc., Glasgow*, vol. xiii., pt. iii.), who promises a more detailed paper on the subject. Teschenite, essexite and trachyte are among the types, and some of the rocks contain much analcime, which appears to be primary. Thus there is an analcime syenite, composed principally of soda-orthoclase, albite and analcime, with purple titaniferous augite, barkevikite and aegerine. Another rock is composed principally of analcime, with a little nepheline, crowded with perfect euhedral barkevikite, sometimes with a little titaniferous augite and plagioclase.

In the *Geological Magazine* for January, 1911, Mr. F. P. Mennell describes dolerites of Rhodesia, containing quartz, either in separate granules or in the form of micropegmatite. The dolerite dykes penetrate the great granite masses of the country, and the quartz, when occurring in good-sized corroded fragments, is obviously derived from the granite. In the case of the smaller granules and the micropegmatite, the origin of the quartz is not so clear. The phemonena are, in some respects, closely similar to those which Professor Judd recorded in certain cases, which seemed to him to prove the secondary origin of micropegmatite and the growth of crystals in rocks after their solidification (*Q.J.G.S.*, May, 1889). In the Rhodesian rocks there is clear evidence that the micropegmatite fringes represent the surviving portions of crystals which have had their exteriors melted or corroded. "The outgrowths are, therefore, as Judd correctly surmised, of the nature of secondary enlargments long after the consolidation of the original nucleus. Where his suggestion was at fault, was in regarding the regrowth as having taken place at the expense of a non-crystalline ground mass. The outgrowths that we have been discussing are clearly due to the re-crystallisation, under the influence of heat, of the exterior portions of the original crystals, together, in some cases, with materials due to reactions with the surrounding crystals or with introduced substances. The light such an observation throws on the occurrences of quartz and micropegmatite among basic rocks, and upon the frequently-noted association of gabbro or dolerite with granophyre, is evident. There seems little doubt that it may usually be ascribed to the partial admixture, prior to intrusion, of acid and basic materials, not necessarily from related magmas, or even entirely of igneous origin."

Very similar rocks to these Rhodesian quartz and micropegmatite-bearing dolerites were described in the same magazine in July and August, 1909, in Mr. G. W. Tyrrell's "Intrusions of the Kilsyth-Croy District." These rocks, from Dumbartonshire, Scotland, are described as granophyric diabase, and the grains of quartz and patches of micropegmatite are said to be primary. It is here suggested that the gabbro-granophyre mélange rocks owe their origin to the interaction of a normal basalt-magma with a highly siliceous country rock, and that the normal granophyric diabases, with their remarkably constant chemical composition, represent the saturation-point of such a magma with silica. The excess of siliceous matter is believed to be thrown out as a separate body of material, usually consolidating as granophyre, in a manner analagous to the separation of the excess of a salt in a saturated solution.

While dealing with rock-magmas and solutions, reference may be made to a paper in the *American Journal of Science* for January, 1911,—"Solid Solution in Minerals, with Special Reference to Nephelite," by H. W. Foote and W. M. Bradley. It is a well-known fact that there are certain minerals to which no satisfactory chemical formulae can be assigned, which agree with the results of analysis. In general, the composition of a mineral, as obtained in analysis, varies from the composition of the ideal pure compound for two reasons, apart from errors of analysis. Either there is *(a)* isomorphous replacement of one element or radical by another, or *(b)* there are mechanical impurities present. The authors call attention to another influence, which must probably be taken into account in cases like that of nepheline (to which the formulae $NaAlSiO_4$ and $Na_8Al_8Si_9O_{34}$, besides others more complicated, have been given). It is assumed that in certain cases a substance on crystallising forms a solid homogeneous solution with foreign matter, which is neither isomorphous with any constituent, nor can be regarded as a mechanical mixture. It can be compared to the solution of salt in water, in which the salt takes on the appearance and form of the water without taking any part in the formula of the water. The authors maintain that the pure compound, which forms the basis of nepheline, is the orthosilicate $NaAlSiO_4$, and that the observed variations from this are due to silica dissolved in the silicate. Just as very little is known about the condition of dissolved substances in liquids,

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as to whether they are combined with the solvent, so in this case it is impossible to say whether the silica is present as dissolved albite or silica, or leucite, or in any other form. The excess of silica which can be taken up by nepheline to form a saturated solution can apparently be determined. Where albite is found intimately mixed with nepheline it is evident that the nepheline must be saturated with silica, and the excess of the latter has formed albite. The authors suggest the application of their arguments to other minerals, and state that work has already been begun on pyrrhotine, the magnetic sulphide of iron, the formula of which is variously given as Fe_6S_7, Fe_7S_8, and so on. In this case, analyses vary from Fe_5S_6 up to $Fe_{16}S_{17}$, while conforming to the general formula Fe_nS_{n+1} (Dana's "Textbook of Mineralogy").

METEOROLOGY.

By JOHN A. CURTIS, F.R.MET.SOC.

THE weather of the week ended December 17th was rough and squally, with high temperature and much rain. Of the twelve districts into which the British Isles are divided for meteorological statistical purposes, five were noted as being very unusually warm, six as unusually warm and only one (Ireland S.) as moderate.

The excesses above the average varied from 3°·5 in the English Channel to 9°·1 in England E. The highest maximum was 57° which was recorded at Geldeston and also at Jersey, but in all districts readings of 50° or upwards were recorded. The lowest readings were 30° at Strathpeffer and Nairn on December 16th, but at no other stations in the British Isles did the temperature fall below the freezing-point. The rainfall was in excess in all districts, except Scotland N., where it was but little more than half the normal amount. In England S.E., the rainfall was three and a half times as much as usual. At many stations rain was measured each day, and at Llangammarch Wells, the total for the week was as much as 4·74 inches. Sunshine was generally below the average; in many places very much so. At Westminster, the total duration was 2·9 hours, or 5%. At Greenwich it was 6·7 hours or 12%. There was much strong wind during the week, and on the 16th there was a severe and widely-spread gale. The temperature of the sea water varied from 51° at Salcombe to 41° at Cromarty.

The week ended December 24th was much drier than those which had preceded it; still rain fell frequently, and at several stations on every day. The aggregates were less than the average in all districts except Scotland N., where it was double the usual amount. In England N.E., the rainfall amounted to only 0·08 inches, or less than one-sixth the normal. Temperature continued high, and there was excess in each district, as much as 6°·0 in Scotland E. The highest reading recorded was 57°, but in all districts readings of 53° and upwards were recorded. The lowest minimum was 27°, at Swarraton, Hants. Bright sunshine was also in excess generally, though some curious anomalies were reported; thus, for instance, at Birr Castle the total duration was 8·2 hours in excess, while at Dublin it was 7·0 hours in defect. The mean temperature of the sea water was higher than in the corresponding week of last year by as much as 6° at some stations. The individual readings ranged from 51° at Salcombe, to 40° at Pennan Bay and at Cromarty.

The weather of the last week of the year was unsettled, but there were bright periods in most parts, and several dry days. Temperature was rather above the average as a rule, and readings of 50° or above were recorded in all districts except Scotland E. The highest maximum observed was 53° at Killarney and at Jersey, while on the other hand the lowest recorded was 18° at West Linton, on the 28th, and 19° at Llangammarch Wells on the same day. On the grass the temperature fell to 8° at Llangammarch Wells, to 15° at Tunbridge Wells and to 16° at several places. Rainfall was scanty except in Scotland N., the amounts in many places being one-fourth or less of the average; at Leith the total for the week was only 0·01 inch. Sunshine was generally in excess, and the largest aggregate recorded, namely 25·3 hours, at Hastings, was 47% of the possible duration. On the other hand, at Westminster the total duration was only 2·7 hours or 5%. The sea temperature showed a considerable decrease as compared with the previous week and ranged from 50° at Scilly and Plymouth to 39° at Cromarty.

The weather during the first week of 1911 was generally dull and wet, except in the North-West, where it was dry and fine. Temperature was below the average, except in England, N.E., where it was 0°·2 in excess. The defect was, however, as a rule, not of great amount. Individual readings exceeded 50° in most districts, and in Ireland S., on the 7th, 52° was reported, both at Killarney and at Valencia. Frost was experienced in all districts except the English Channel. The lowest of the minima were 16° at Balmoral, 20° at Nairn, West Linton, and Strathpeffer, and 21° at Birr Castle and Cahir, in Ireland S. The readings on the grass were as low as 9° at Llangammarch Wells, and 14° at Balmoral. Rainfall was above the average in England N.E., E., and S.E., but was deficient elsewhere. In Ireland S., the aggregate fall was but little more than half the usual amount. Sunshine was, as usual, greatest where rainfall was least; the percentages of its possible duration ranged from 14% in England, N.E., to 37% in Ireland N. At Westminster the total duration of Sunshine for the week was only 0·6 hours. At Aberdovey it was 22·2 hours. A severe thunderstorm, accompanied by snow and hail, was experienced in Norfolk during the early hours of January 2nd.

The week ended January 14th was unsettled, with rain during the earlier days and sleet and snow later. Temperature was below the average in England S.W., English Channel, and in Ireland, but above it elsewhere. The departures from the mean, however, were not large. The highest reading was 54° at Killarney on the 8th, and temperatures of 50° or upwards were reported from each district. The lowest minimum was 22° at Kilmarnock and at Cally, Gatehouse, on the 13th. At several other stations the readings were below 25°. On the grass the temperature fell to 12° at Newton Rigg, and to 14° at Tunbridge Wells. Rainfall also was not far from the mean, being below it in the Midlands, England S.W. and in Ireland; equal to it in England N.W., and above it in the other districts. The heaviest fall was on the 10th when 1·36 inches fell at Poltalloch, 1·17 inches at Fort William, and 1·04 inches at Aspatria. Sunshine was in excess in all districts except Scotland N., where it was slightly in defect. The greatest divergence from the mean was in England S.W., where the district value for duration was 17 hours as compared with an average of 10 hours. At Westminster the aggregate was 8·1 hours (15%); at Falmouth 23·8 hours (42%). A thunderstorm occurred at Newcastle-on-Tyne on the 12th. Aurora was seen in Scotland on the 8th. The temperature of the sea water varied from 49° at Scilly and Plymouth to 36° at Cromarty.

THE RAINFALL OF 1910.—Dr. H. R. Mill, of the British Rainfall Organization, has an interesting article in the last number of *Symons's Meteorological Magazine* upon the Rainfall of the past year. The year was a wet one in nearly all parts of the Kingdom. The principal parts of the country having less than the average amount were Western Ireland (Counties Galway, Mayo, and part of Clare); Western Scotland (Argyll and the Western islands), South-Eastern Scotland and North-Eastern England; and a narrow strip on the coast of South Wales. Each country, however, had an excess, England and Wales of 11%, Scotland 2%, and Ireland 9%. For the British Isles, as a whole, the excess was 8%. February was the wettest month, with 61% excess, and September was the driest month, with 69% defect.

September, 1910, was one of the driest Septembers on record, and February was one of the wettest Februaries. The total rainfall for the ten months, January to September, was almost exactly equal to the average fall for the whole year.

Since 1889 there has been a marked sequence of two dry years followed by one wet year, but this relation has now broken down, and we have had two wet years in succession. Dr. Mill adds: "It seems possible that the swing of the pendulum is carrying us into a period of predominating wet years, corresponding to the wet period of 1874–1883."

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MICROSCOPY.

By A. W. SHEPPARD, F.R.M.S.,

with the assistance of the following microscopists:—

ARTHUR C. BANFIELD
JAMES BURTON.
THE REV. E. W. BOWELL, M.A.
CHARLES H. CAFFYN.
ARTHUR EARLAND, F.R.M.S.
RICHARD T. LEWIS, F.R.M.S.
CHAS. F. ROUSSELET, F.R.M.S.
D. J. SCOURFIELD, F.Z.S., F.R.M.S.
C. D. SOAR, F.R.M.S

DR. ERNST LEITZ.—We have much pleasure in announcing that the University of Marburg has conferred the degree of Doctor of Philosophy *honoris causa* upon the principal of the optical works, Wetzlar. We congratulate Dr. Ernst Leitz on his well-deserved honour.

A NEW MICROSCOPE LAMP.—The lamp consists of a five-inch circular base, having a telescopic square vertical tube about six inches long, formed of two square tubes sprung so as to slide the one within the other. The outer tube is plugged at the bottom with brass and terminates in a three-eighths inch brass screw, fitting into a hole tapped in the base to receive it. This is turned up square at the bottom to ensure the upright tube being truly vertical. The inner tube is plugged at the top and terminates in a square boss bored and tapped (three-eighths of an inch thread) brass on two faces, but not right through—the two holes communicating with each other to pass gas, but not permitting gas to go into the inner tube. One face of the boss carries a one-and-a-half inch length of three-eighths inch tube having an ordinary three-eighths inch burner elbow screwed on to it. The other face has screwed into it a wooden nipple bearing a three-eighths inch screw, and formed to take a rubber tube. The nipple should be of hard wood in order that the heat of the lamp is not conducted to the rubber tube. The burner elbow projects downwards with a male thread three-eighths of an inch and takes an ordinary bijou incandescent burner of from thirty-five to forty candle power. In place of an ordinary glass shade, an opaque shade of one-and-three-quarter inches brass tubing is constructed, cut to take a projecting window for various light modifiers of glass three inches by one-and-a-half inches. Three holes in the top of the shade to match screws in the burner serve to attach it. The whole shade is chemically blacked to keep back extraneous and unnecessary light. As the ordinary lamp is seldom of more than four-and-a-half to five candle power the gain in illumination is very great, and the light being white instead of yellow, still further accentuates the advantage. For dark ground and polariscopic illumination, or that of opaque objects, the gain is enormous and, the mesh of the mantle in these cases forming no disadvantage, it can be recommended. It is not put forward for *critical* illumination with high powers but for more general use, where a brilliant rather than a critical light is desired.

FIGURE 1.
A New Microscope Lamp.

With the silver side reflector the results are singularly bright and beautiful. As the gas does not traverse the upright tubes, it can be used at any height either above or below the stage.

CHAS. E. HEATH, F.R.M.S.

ROYAL MICROSCOPICAL SOCIETY.—December 21st, 1910, Mr. E. J. Spitta, L.R.C.P., vice-president, in the chair. W. R. Traviss: A small microscope lamp, particularly suited for opaque objects and dark-ground illumination with high powers. The light used was a small inverted incandescent burner, carried at the extremity of a short arm, that could be easily moved up and down on a standard. The light could be brought very close to the table or raised to illuminate opaque objects on the stage.—M. J. Allen: An easy method of treating printing-out paper for all kinds of photography. The author recommends that the prints be washed in a strong solution of salt, then placed in a saturated solution of hypo., after which they are to be washed in running water.—Chas. H. Higgins: A new system of filing slides.—A. A. C. E. Merlin: On the measurement of Grayson's new ten-band-plate. The plate, comprising ten bands running from $\frac{1}{10000}$th to $\frac{1}{10000}$th of an inch, had been ruled by an improved machine, and was found to be much better even than Grayson's earlier productions. The author in measuring the bands used a selected objective of 1·32 N.A., having an initial magnification of one-hundred-and-forty-three on a ten-inch tube. A Nelson-Powell screw-setting micrometer, which is alone suitable for the purpose, was used. The result obtained was that the variation from the mean in the spacing of the lines did not exceed $\frac{2}{25000}$-inch. The mean diameter of the lines was ·00002488-inch. The author also made a series of measurements with one-inch, half-inch, and quarter-inch objectives, and came to the important conclusion that low powers were unsuited for micrometry.—Jas. Murray: Some African rotifers — Bdelloida of tropical Africa. Thirty-three species of Bdelloids were obtained from dried moss, sent by Mr. A. Allan and Sir Philip Brocklehurst, from British East Africa. Nine of the species are new to science. Several of them have very distinct characters, not previously noted for any Bdelloids. *Habrotrocha caudata* has a tail-like process, the function of which is unknown. The animal secretes a protective shell, and the "tail" is enclosed in a slender tube, open at the end, so that the shell has two openings. *Habrotrocha acornis* has no trace of spurs, otherwise universal in the order. Several other species approach it in this respect, having the spurs reduced to minute papillae. *Habrotrocha auriculata*, when feeding, has at each side of the head a peculiar ring-like auricle, giving it the appearance of a two-handled vase. The nature and function of the auricles remain unknown. Their form, even, is difficult to interpret, as they present apparently contradictory appearances from different points of view. The Bdelloids take a very important place in moss-faunas. In every country they are abundant, and in most regions there is a fair proportion of peculiar species. When more fully known, the Bdelloids seem

likely to prove a group of hitherto unsuspected importance, both in point of numbers and diversity of forms. All these moss-dwellers can revive after desiccation. The adult animals become dormant when deprived of moisture and revive when re-moistened. It is not, as Zacharias concluded from his experiments in 1886, that the survival of the species is effected by means of eggs.

Mr. A. Earland gave a lantern lecture dealing with the apparatus and methods employed in the cruisers of the International North Sea Commission, with special reference to the work of the "Goldseeker," the cruiser of the Scottish branch of the Commission.

THE MICROLOGIST.—We have to acknowledge the receipt from the publishers, Messrs. Flatters, Milborne and McKechnie, Ltd., of the third part of their quarterly. It well maintains the character set in the previous parts and contains full practical details for the staining and mounting of animal and vegetable tissues, such as the pinnae of Ferns and the head of the Crane-fly and Hive-bee. Pages 35–37 are devoted to the methods adopted for embedding in Celloidin, and the cutting and staining of such sections as those of the head of the Blow-fly. There are collotype reproductions of photo-micrographs of several of the objects described. Mr. Chas. Turner, F.C.S., contributes an article on Collecting and Preserving Freshwater Algae. We much regret to see so many errors in the printing of scientific names, and would suggest to the publishers a more careful revision of the proof sheets.

We have also received a selection of the slides illustrated and described in Parts 1–3, and can recommend them both for quality and moderate price. The slides received with Part 3 are: vertical section of the head of the blow-fly, the pinna of *Aspidium Filix-mas*, stained and mounted entire, and the fruiting spike of *Selaginella* sp., showing macro- and micro-sporangia.

THE PREPARATION OF A ROCK SECTION.—When commencing the preparation of a rock section, either by hand or with the aid of a machine, the first thing to be done is to procure a suitably-sized chip or slice. The size I usually start with is from three-quarters of an inch to one inch square. This will probably lose a little in grinding, but will be a fairly large piece when finished.

If the work is to be done entirely by hand, it will be found possible in most cases to strike off suitably-sized chips with a trimming hammer, or by the aid of a chisel. The thinness of these chips will depend entirely on the texture of the rocks, and while it will be found comparatively easy to get large flakes off fine grained rocks, such as basalts or andesites, it is difficult to get even thick lumps off the coarse granitoid rocks. With the slitting machine, described and illustrated in "KNOWLEDGE" for January, page 30, however, it is easy to get slices about $\frac{1}{32}$nd of an inch, or even less, and it will be seen at once that this saves a lot of time in grinding.

The method usually recommended for using a slitting disc is to rub the edge with powdered diamond or bort, made into a paste with oil so as to incorporate it in the soft iron to make the cutting edge, but I have found a much easier and *cheaper* way is to apply a paste of carborundum and water with a camel-hair brush to the cutting edge just above the rock specimen. The grade of carborundum I use for this purpose is No. 150, which cuts fairly fast, and I find by actual timing that I can get through an inch of any ordinary igneous rock in from six to eight minutes without undue exertion.

When starting to cut a slice with the machine the rock is clamped in the holder in the proper position, so that the piece can be cut in the direction required, and the spindle is then screwed forward so that the rock projects over the cutting edge of the disc. The disc is made to revolve toward the operator, the edge is wetted with the carborundum paste, and the rock is then allowed to touch the wheel. It is advisable to keep the rock against the disc by the aid of the thumb of the left hand so as to prevent it from jumping. The edge of the disc must be kept well supplied with the carborundum and water, as the cutting is then much expedited.

When one piece is cut off, the rock is lifted free of the disc, and is moved forward by the spindle ready for the next slice to be cut.

Having obtained a suitable piece, either by chipping or cutting, the next thing to be done is to make one side of it perfectly plane and smooth. This can be done by rubbing the rock on a piece of plate glass, say, six to eight inches square, which is moistened with carborundum and water. A zinc or copper plate can be used instead of the glass, but I have found the glass to cut better and work more quickly. I use the same grade of carborundum for this as I do for slitting, as I find No. 150 is not coarse enough to tear the rock or fine enough to make the work tedious. Coarser grades can, of course, be used, if thought desirable, but it is not advisable to use anything coarser than No. 90.

With the machine described in the January number the rough grinding is done on the lap. I usually make the lap revolve in the opposite direction to the hands of a watch, and hold the rock in the fingers of the left hand against the left side of the lap, so that I push against the revolution of the wheel. This I have found easier than pulling against the wheel. It must be borne in mind that the periphery of the wheel cuts faster than the inner portions, and the section, therefore, must be frequently twisted and moved backward and forward from the edge of the wheel to the centre so as to keep a plane surface.

When a perfectly flat surface has been procured, the rock must be rubbed by hand on a sheet of glass with finer carborundum, say No. FF, so as to remove all coarse scratches. Care must be taken at this stage not to get any coarse powder on to the glass plate, or it will cause bad scratches on the rock. The latter can be finished off on FF emery cloth, which is supported on a glass plate, and it is then polished on a piece of worn emery cloth, No. 0. It is not necessary to get a high polish with ordinary igneous rock, so long as there are no scratches.

The next process is to fasten the piece of rock to a suitable handle for the grinding of the reverse side. It is customary to employ pieces of plate glass for this purpose, and those I use are one-and-a-half inches square. Various cements are used for fixing the rock, the one generally adopted being ordinary hard Canada balsam, although a better one can be made of Venice turpentine and commercial shellac (bleached), which can be procured at any ordinary paint and varnish shop. The proper proportion is about three of Venice turpentine to one of shellac. The turpentine is melted in a water bath, and the shellac is then stirred in, a little at a time, until it is thoroughly incorporated. Test the cement by dropping a little on a cold glass plate, and if it dries practically at once into a hard glassy bead, it is all right. If it is greasy-looking it needs more shellac, and if it is too brittle and chips, more turpentine must be added. When it is of the right consistency, it is poured out on a glass plate, and rolled into sticks like sealing wax, ready for use.

To cement the rock to the glass, put the latter on a hot plate over a spirit lamp and place a small portion of the cementing material in the centre. At the same time lay the rock on the hot plate to warm. When the cement melts and runs, pick up the rock in a pair of forceps and place it in the centre of the cement. Press down hard to squeeze out the excess of cement, taking care that no bubbles remain between the rock and the glass. If there are any, the rock must be melted off and the work started again. When the rock is cemented satisfactorily the glass plate is put away to get cold, say, for about an hour. Take care when heating the cement not to make it too hot so that it smokes, as this drives off too much of the turpentine and makes it brittle.

A method that I have found very satisfactory for fastening the rock to the plate glass holders is to use gum arabic, made into a thick solution about the consistency of treacle. A drop of this is put in the centre of the glass, the rock is placed in position and the excess squeezed out gently with a slight twisting motion. This will dry in about twenty-four hours and the rock can then be ground down in the usual way.

Having securely fixed the rock to the glass plate, the next step is to grind it down sufficiently thin. If the work is being done entirely by hand, and the rock has been cemented to the

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glass with balsam or shellac, it should now be rubbed on the glass plate until the section becomes translucent. During this operation the plate must be well supplied with a paste of carborundum powder and water, using plenty of water. The rubbing is done with a circular motion, and it is advisable to make the circles as small as possible, as then there is then less tendency to bevel the edges of the section. Care should be taken also to do the rubbing over the entire surface of the plate, so that it wears evenly.

If, on the other hand, the rock has been fastened on with gum arabic, the rough grinding by hand must be done on the glass plate with *dry* carborundum powder or otherwise the water will cause the rock to leave the glass. The rough work is done so quickly, however, with the grinding lap on the machine, that it can be used whether the rock is cemented with shellac or gum arabic, as the grinding is so rapid that the gum has no time to dissolve. When doing the rough grinding on the lap, great care must be taken that the section is ground evenly on all sides, and that the operation is not carried on too long, because the lap is revolving so rapidly that in a few seconds the whole of the rock may be removed from the glass.

It is difficult to give directions as to how long this grinding with the coarse powder should be continued, as it depends, in a great measure, upon the rock itself, but a little practical experience will soon decide this for the operator. A rough-and-ready rule is to stop when the rock shows signs of chipping off at the edges.

It should then be transferred to the other glass plate, with finer carborundum, and the grinding continued by hand until the rock is sufficiently thin. Great care must be taken in these later stages, and the rock must be examined under the microscope from time to time to see if it is thin enough. The final rubbing must be done on Water-of-Ayr stone, or one of the very fine carborundum stones used for razor sharpening.

When the rock is fixed with gum arabic, the final grinding, after the use of the lap, is done on a glass plate with FF carborundum used dry, finished off on FF emery cloth, and polished on No. O emery cloth. As mentioned previously, it is not necessary to get a high polish, and any small scratches are practically unnoticeable when the section is mounted in balsam.

The next operation is to remove the section from the glass holder. If it is cemented with balsam or shellac, it should be placed in ordinary commercial methylated spirit, and must remain out of reach of dust until it has left the glass. This usually takes some time, but it must not be assisted in any way by pushing the section with a brush or needle, as this is almost certain to destroy it.

If it is stuck on with gum, it is simply put in water and usually leaves the glass in about an hour. In either case after the rock has left the glass, it is rinsed in clean methylated spirit, and is then ready for mounting.

When moving the sections from one receptacle to another I always use large section lifters about one-and-a-half inches by one inch. These I cut out of thin sheet brass with a pair of scissors. They have practically no handle, and will, therefore, stand where they are placed without falling backwards. I find these very useful when placing sections in the final methylated spirit, as lifter and section are put in the receptacle together.

The mounting is done in the ordinary way in balsam and benzole. The most difficult part is the transference of the section from the lifter to the glass slip. The section when taken from the spirit is pushed with a sable brush carefully over the edge of the lifter until it projects as far as is safe, and is then picked up on the hairs of the brush, and transferred to a heated slide. The heat of the slide soon evaporates the spirit, and then a drop of balsam can be applied to the edge of the section, under which it will be drawn. Arrange the section in position on the slip with a needle, examine under the microscope with *polarized* light to see there are no bits of fluff or other foreign substance, put a drop of balsam on the section and then the cover glass.

C. H. CAFFYN.

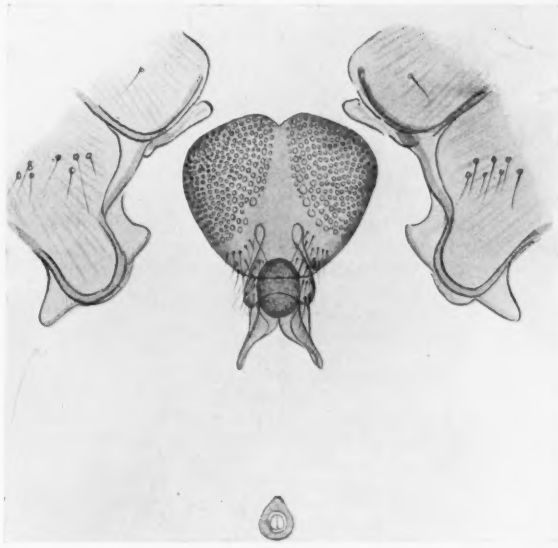

FIGURE 1.

Ovipositor and Egg of *Hydrachna geographica* × 56.

NOTE ON *HYDRACHNA GEOGRAPHICA* MÜLL.—In May last, Mr. Braithwaite found a female *Hydrachna geographica* Müll, in Epping Forest. This mite is the largest of all the known water mites. The female often measures as much as eight millimeters long in the body. Mr. Braithwaite, hearing I was in want of a fully-developed female of this species, kindly sent it on to me. After I had drawn and measured the mite I dissected out the epimera and genital area, and mounted that part in balsam for future reference and for comparison with other species of the same genus. I did not know before, but while I was examining it during mounting I found the ovipositor was fully extended and that an egg was in the act of leaving the tube, and I am pleased to say this position has been retained, even now it is permanently mounted in balsam. I have mounted hundreds of genital areas of water mites, but never had the good fortune to find one like this before, and I do not expect to ever find another. I mounted it without pressure, placing the cover glass on the liquid balsam and allowing it to settle down by its own weight. No doubt the slightest pressure would have squeezed the egg out of its position. The length of the genital plates with the ovipositor is 1·04 mm., length of egg 0·24 mm. The drawing was made under the camera-lucida, with one-inch objective. It shows the exact position of the genital area, and its position between the third and fourth pair of epimera. The female was full of ova, but the eggs in the body were spherical, so the oval form taken by the egg shown in the figure is no doubt due to it being squeezed through the ovipositor.

CHAS. D. SOAR, F.R.M.S.

THE DIVISION OF THE COLLAR-CELLS IN *CLATHRINA CORIACEA*.—In the November number of the *Quarterly Journal of Microscopical Science* (Vol. 55, p. 611) a contribution is made under the above title, by Miss M. Robertson and Professor E. A. Minchin, to the theory of the centrosome and blepharoplast. It is now generally admitted that these bodies are of essentially the same nature. The centrosome may be briefly characterised as a body which exerts or governs kinetic functions in relation to division of the nucleus, while the latter, or blepharoplast, may be defined as a centrosome which governs motile organs, such as flagella, which arise from it, and are in more or less direct connexion with it. The results are briefly summarised by the authors at the end of the paper. The nucleus of the collar-cell migrates from the base to the apex of the cell, and so comes to lie immediately under the blepharoplast. The flagellum disappears, and the blepharoplast divides. The two daughter-

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blepharoplasts now travel to opposite sides of the nucleus, and take on the function of centrosomes. The nucleus breaks up into chromosomes, its membrane disappears, a mitotic spindle is formed in the usual way, with the two centrosomes at its poles. The two new flagella then at once begin to grow out from the two centrosomes, outside the original collar and before the equatorial plate is divided. The mitosis is completed, and as the cell-body divides, the original collar breaks down and disappears. The centrosomes become the blepharoplasts of the two daughter-cells, the flagella continue to grow out from them, the new collars grow up round the new flagella, the daughter-nuclei return to the bases of the cells, and the two daughter-cells resume the structure and appearance of the ordinary resting collar-cell. It is thus seen that the blepharoplast-centrosome is a permanent cell-organ which divides with the cell, while the collar and flagellum are formed afresh at each cell-division.

ORNITHOLOGY.

By HUGH BOYD WATT, M.B.O.U.

THE BOYD ALEXANDER COLLECTIONS.—The very fine and extensive collections of bird-skins made by the late Lieutenant Boyd Alexander, in the course of his scientific journeys in Africa, are to go to enrich the national collections at the Natural History Museum, South Kensington. Lieutenant Alexander, who, it will be remembered, was killed in the course of explorations in Africa last year, died intestate, but, in accordance with his wish, the Museum above-named is to have his collections. These are housed at present in a private museum, which was specially built for them at Wilsley. The collections are from wide areas in Central Africa, visited since 1897, including the Cape Verde Islands, Zambesi River, Kumassi, Fernando Po, and the great regions travelled through from 1904 to 1907, described in Lieutenant Alexander's book, entitled "From the Niger to the Nile," also from the islands of San Thomé, Principe and Annabon, and Cameroon. Lieutenant Alexander obtained many species new to ornithology and science, and described (and in some cases figured) them in the pages of the *Ibis*, and of the *Bulletin of the British Ornithologists' Club*. In a comparatively short life, devotion to his favourite pursuit yielded a rich harvest, and the memory of this intrepid traveller and ornithologist will be further perpetuated by this splendid gift to the nation and to science.

MIGRATION.—It is good news to ornithologists that Mr. William Eagle Clarke, of the Royal Scottish Museum, Edinburgh, is about to publish a work dealing with the study of bird-migration in the British Isles. It is not too much to say that, despite much writing (or, perhaps, because of it) knowledge lingers here, still in the obscurity of conjectures and surmises, and the time is ripe to attempt an advance on a genuine scientific basis. From no one is new and clear light more likely to come than from Mr. Clarke, who has devoted many years, dating back to the days of the Migration Committee of the British Association, to the study and accumulation of facts and observations. Besides having at his command the long series of reports made year after year by many observers and recorders throughout the country, Mr. Clarke has, within recent years, spent lengthened periods at the migration seasons in outlying localities from the Eddystone Rock in the south to the remote islands in the north, on the fly-lines, or routes of migrants. Readers of his preliminary reports and notices know that he has gathered abundant and rich results. A mere enumeration of species does not in itself throw light on migration problems, still it is notable that the small Fair Isle (between Orkney and Shetland), has yielded records of no less than one hundred and ninety eight species of bird visitors, including many which experienced ornithologists have never seen in Britain. For instance, the year 1910 gave three species new to the fauna of Scotland, viz., the Hoary Redpoll (*Acanthis exilipes*), Holböll's Redpoll (*A. linaria holboelli*)—a second example occurred on the Isle of May, October 23rd—and the Yellowshank (*Totanus flavipes*). (*Ann. Scot. Nat. Hist.*, January, 1911, page 53).

A NEW BRITISH BIRD.—Amongst the birds observed and procured by Mr. Wm. Eagle Clarke at St. Kilda—the furthest west and most remote of the British Isles—last autumn (1910), was the American Pipit (*Anthus pensylvanicus*), new to the British fauna, and the Marsh Warbler (*Acrocephalus palustris*), new to Scotland. (*Ann. Scot. Nat. Hist.*, January 1911, page 52). The rarity of the Pipit named is so great that the only mention of it to be found in Dresser's "Manual of Palaeartic Birds" (1902) is a statement that it so nearly resembles *A. spipoletta* as to have been included, in error, as a European bird.

A PROPOSED CENSUS OF THE COMMON HERON (*Ardea cinerea*).—Such a bird as this, large in size and sedentary in habits, affords the possibility of some success attending an attempt to number the individuals in a limited area. A proposal is being mooted to undertake this enumeration in Scotland, where the location of the Heronries, which are widely distributed over the mainland, is pretty accurately known at present. This wide distribution may, however, prove a serious difficulty in the attainment of accuracy or completeness of returns. The numbers of several species of British birds are known, but these are mostly inhabitants of restricted areas or individually scarce, or where the species may be called common, *e.g.*, the Gannet, its occurrence is concentrated (at any rate at the breeding season) at a few well-known stations.

PHOTOGRAPHY.

By C. E. KENNETH MEES, D.Sc.

THE MICROSCOPIC STUDY OF DRY PLATES.—Dr. W. Scheffer, of the University of Berlin, in his lecture at the Royal Photographic Society on December 20th, described the investigations which he has made on the effect of exposure and development upon the individual grains of a gelatino-bromide emulsion. He has designed for his work a very complete experimental equipment, and his photographs are all taken at a magnification of two thousand diameters, much higher than has been used by previous workers in the subject. Photographs taken of grains during the process of development show that the grains are of two kinds, which Dr. Scheffer distinguishes as "original grains" and "nourishing grains." The original grains have filaments projected from them, either during exposure or at the commencement of development, and Dr. Scheffer concludes, from his later observations, that grains showing these filaments remain unaltered during the progress of development, and become covered by the metallic silver which is deposited upon them, this metallic silver being derived from the solution of the "nourishing grains," which disappear during development. When a plate is under-exposed there are few original grains present, and with over-exposure many original grains and few nourishing grains, a fact to which Dr. Scheffer ascribes "the lack of density produced by over-exposure." This seems to require re-consideration, because ordinary over-exposure does *not* produce lack of density; the thinness which most amateurs assign to over-exposure is due to under-development; if an over-exposed plate be developed for the normal time, it will be extremely dense all over. Possibly, however, Dr. Scheffer intended the reversal period by "over-exposure." The connection of these observations with the known facts as to the chemical dynamics of development will require a great deal of work. It is not at all obvious, for instance, that a steady growth of original grains and diminution of nourishing grains would be in harmony with Hurter's "Law of the Constancy of Density Ratios," which is the photographic equivalent of the mass-law.

Moreover, the statement that there are silver bromide grains in the film of a plate which are unaltered in development and which can survive fixation, should be capable of confirmation by chemical experiments on plates in the mass, and the amount of such grains should be readily ascertainable if developed and fixed plates are treated with a solvent of silver which is incapable of affecting silver bromide. Dr. Scheffer showed an experiment in which this was done, but this would require confirmation by quantitative measurement on masses of developed

film sufficient for the purposes of ordinary chemical analysis.

If the quantity of these unattackable grains varies with the exposure it would seem probable that the amount of metallic silver required to produce a given light absorption would vary with the exposure also, and it is known that such variation must be very small if it occurs at all.

A most interesting experiment of Dr. Scheffer's would seem to suggest that the "filaments" can scarcely be produced during exposure. A small quantity of emulsion was placed on a slide and a most powerful beam of light passed through it by a Zeiss projection apparatus and microscope, the image being projected on to a screen.

Under these conditions the grains could actually be observed to decompose under the action of light, shooting out the "filaments" or clouds of nebulous matter, and going black with growths, apparently of metallic silver, upon them. The amount of light required to produce this effect is very great, however, and there seems to be every reason for doubt as to whether any actual decomposition of the grain is produced by ordinary exposures.

Dr. Scheffer also described the investigations which he had made as to the distribution of the image in the film of the ordinary dry plate. The great difficulty in such work is the preparation of sufficiently thin sections, since for first-class results the sections should not be thicker than $\frac{1}{2}\ \mu$ ($\frac{1}{2000}$th mm). By the aid of a special microtome of his own construction, Dr. Scheffer has been able to attain to most excellent results, and one photograph, showing not only the Zenker's laminae in a Lippmann plate, but the actual grains composing them, was a marvellous testimony to the perfection of Dr. Scheffer's methods.

Most of the results obtained from sections confirm those of previous investigators, but the studies of the action of various "reducers" are of special interest, and make very clear the known differences between the various oxidising agents employed to reduce the density of photographic negatives.

DEVELOPMENT WITH HYDROQUINONE. — The chemical reactions involved in development are generally complicated, and the oxidation products of the organic developers are especially obscure.

One of the simplest of the organic developers is, of course, hydroquinone, which is oxidised to quinone by silver bromide.

Using the ordinary nomenclature, the reaction will be

$$C_6H_4(OH)_2 + 2AgBr + 2NaOH \rightarrow C_6H_4O_2 + 2Ag + 2NaBr + 2H_2O,$$

one molecule of hydroquinone producing two atoms of silver.

It has been shown that this reaction is reversible, quinone and soluble bromide having the power to oxidise a silver image to silver bromide. So that quinone and a soluble bromide will act as a photographic reducer (of density) as has recently been pointed out by MM. Lumière and Seyewetz.

But the simple equation given above does not by any means express the whole of the reactions taking place in a hydroquinone developer containing alkali and sulphate.

Quinone reacts with sulphite, oxidising it to Dithionate and being reduced to Hydroquinone thus:—

$$Na_2SO_3 + C_6H_4O_2 + 2H_2O = Na_2S_2O_6 + 2NaOH + C_6H_4(OH)_2$$

Moreover, the addition of an alkali to quinone reduces some of it to hydroquinone, apparently being oxidised to peroxide, since the ether extract gives the characteristic blue colour with acid bichromates. So that both the sulphite and the alkali regenerate the reducing agent from its oxidation product, and the development reaction becomes far more complicated than would at first appear.

PHYSICS.

By W. D. EGGAR, M.A.

WAVES *VERSUS* RAYS.—A good many years ago Professor C. V. Boys took a series of photographs of flying bullets. In these a prominent feature was the wave from the bow of the bullet, as from the bow of a steamer. It was a wave of compressed air, made instantaneously visible to the eye of the camera by the spark which took the photograph. In fact, it was a wave of sound. Following up this discovery, Professor R. W. Wood took a series of photographs of sound waves, issuing from a central point. The sound was that of an electric spark, and the photographs were taken by the light of another spark, following close upon the heels of the noisy spark. The interval between the two sparks could not be regulated with any accuracy, but a large number of photographs were taken, which are published in the form of lantern slides, and appear also in Wood's "Physical Optics." They illustrate many of the main features of wave-motion, and are exceedingly useful in explaining the wave-theory of light. In a paper read to the Physical Society on "Cusped Waves of Light and the Theory of the Rainbow," Mr. W. B. Morton alludes to the tendency at the present time to base the teaching of Optics on the conception of the wave, rather than that of the ray. This tendency was further exemplified at the annual meeting of the Public School Science Masters' Association, at which Mr. J. Talbot gave a demonstration of his use of the ripple-tank. This is a large flat glass tank with water in it to a depth of about half an inch. It is supported at the height of an ordinary table above the ground on which is placed an arc light, screened from the class. A translucent screen tilted above the tank on the side of the class receives the shadows of the ripples made in the surface of the water. The velocity of the ripples can be altered by altering the depth of the water, and this can be done by flat glass plates. Hence, many of the features of reflection and refraction can be demonstrated by the medium of surface ripples. The method forms a most useful addition to the equipment of a teacher of Optics. At the same meeting, Mr. C. F. Mott exhibited his apparatus for teaching Optics by the method of rays. In place of the usual pins employed in elementary practical Optics, Mr. Mott uses a beam of light coming through a pair of narrow slits, fixed at the ends of a groove cut in a block of wood. The conception of rays is, in the opinion of some, the natural introduction to the subject, and if it be right to follow historical order in the presentation of physical knowledge, rays would undoubtedly come before waves. However, as the protagonists agreed, the two methods are supplementary rather than antagonistic; and it must be borne in mind that the teacher of science has sometimes as his aim the stimulation of interest in physical phenomena, at other times the training of the youthful mind in methods of precision.

THE RADIO-BALANCE.—In the December number of the *Proceedings of the Physical Society* there is an important paper by Professor Callendar describing his radio-balance. This instrument is devised for the absolute measurement of the heat of radiation, and is specially applicable for that of Radium and its emanation. The heat imparted by radiation to a small copper disc or cup is directly compensated by the heat absorption due to a Peltier effect created in an iron-constantan thermo-couple connected to the disc, and to a variable source of electric current. The Peltier co-efficient and the value of the compensating current being accurately determined, the heat of radiation can be measured with considerable accuracy, when an exact balance between the two effects is obtained.

ZOÖLOGY.

By PROFESSOR J. ARTHUR THOMSON.

NON-DIGESTIBILITY OF FAT BY PROTOZOA.—W. Staniewicz calls attention to a curious point, that the Protozoa have never learned to digest fat. All Metazoa have this power, but Protozoa have not. Experiments with Paramoecium, Stentor, and some other common Infusorians show that fat may be ingested, but it is not digested. It is not a natural part of a Protozoon's food. The fat sometimes found in natural conditions within the cell of a Protozoon seems to be due to the transformation of proteids or carbohydrates.

MUDDY TASTE IN FRESHWATER FISHES.—It is well known that carp and tench and eels and some other freshwater fishes are apt to be tainted with a peculiarly

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disagreeable taste, which sometimes makes them almost uneatable. The taste is called "muddy," but Louis Léger's experiments have shown that it is not directly due to the mud.

The Stonewort (*Chara*), which has a curious odour, has been blamed, but Léger has shown that the "muddy" taste may occur in fishes from basins without any stonewort. Following the method of exclusion, he has traced the mischief to Oscillarias, those curious mobile Algae, which are common in fresh waters. They are directly or indirectly used by the fishes as food, and it is their "essence" that saturates through the fish-body. The taste is strongest in the glandular parts of the skin and in the kidneys. Carnivorous fishes are less liable to be tainted, but even trout do not escape.

A NEW COMMENSAL TURBELLARIAN.—Professor Edwin Linton found in the ribbed mussel (*Modiolus plicatulus*) at Woods Hole an abundant occurrence of a commensal Rhabdocoele Turbellarian, belonging to the genus *Graffilla* or to a closely-related genus. It is interesting in many ways, *e.g.*, in containing ciliated young, most of which were *in twos* inside a thin capsular envelope. The young are not liberated until the reproductive powers of the mother are exhausted, when they make their way through the ruptured body-wall. Another interesting peculiarity is that the adults, which rarely reach 2mm. in length, move by a series of zig-zags, —a mode of progression which affords constant change of position within the limited area of the host.

DO BLOW-FLY LARVAE RESPOND TO GRAVITY?—S. O. Mast has investigated Professor Jacques Loeb's statement that blow-fly larvae "when placed under the surface of the water, do not swim upwards and so avoid death, but swim downwards." It is found, however, that blow-fly larvae do not react to gravity, either in water or out of it. In air they may be found to crawl nearly straight upwards on objects, but experiments show that this has no relation to gravity. In water they sink to the bottom or float at the top according to the amount of gas they contain, and there is no evidence whatever indicating that they can swim.

PROCESSION CATERPILLARS.—A month or two ago we described observations on the habits of the Procession Caterpillar, *Cnethocampus pinivora*, made at Arcachon by Mr. T. G. Edwards in the Spring of 1909. An account of additional observations and experiments made in the following Spring is now published by Mr. H. H. Brindley. Strangely enough, the greater number of the processions seen by Mr. Brindley were met, not within the forest itself, but on a broad road (over which there was constant traffic) leading towards it. The road was bordered by villas, in many of the gardens of which there were pine trees. Many nests containing living larvae were found on the young pine saplings in the forest, and in all cases the branches near the nest were thickly matted with the threads secreted by the larvae. Very few threads were found on the branches at a lower level, or on the trunk, and of these none reached the ground, so that the threads gave no evidence that the larvae were in the habit of leaving the nest and returning to it. A series of experiments with the thread showed that it has no great importance in the formation of the procession, or even in keeping it together. Head to tail contact seems the important factor, and when that is broken, the detached portion of the procession joins on again, apparently by sight, if the distance is not great. The thread forms the nest in the tree, and the cocoon in the pupa state, but it is not clear why it should continue to be formed when the larva is away from the nest, unless it is to be regarded as a mere secretion. Mr. Brindley made an interesting series of experiments to test the permanency of the leadership. In small processions, each individual caterpillar was dusted with a powder of a different colour, and the procession was interrupted. In fifty per cent. of cases the same leader took the head of the procession, whether mass-formation was natural or artificial; the leader for the time being undoubtedly determining the behaviour of the procession, since contact is always maintained. The leader always takes the initiative in mass-formation and very frequently in burrowing.

The observer did not experience any irritation on handling the caterpillars, and he believes, with his collaborator, that the degree of sensibility to the glandular hairs varies with the individual.

YAWNING IN FISHES.—Mr. Richard Elmhirst, Superintendent of the Millport Marine Biological Station, has made some very interesting observations on Yawning in Fishes. He has watched it in cod, saithe, cobbler, plaice, and some others. He describes the wide opening of the mouth, the slow expansion of the buccal cavity, the erection of the gill-arches, and then a rapid expulsion of the indrawn water, mostly from the mouth, partly through the gill-slits. This is often accompanied by a distinct heaving of the pectoral region and erection of the pectoral fins, and is quite different from the rapid movement of the gill-cover and jaws when the fish dislodges a bit of seaweed from its gills. "From numerous observations, I am led to think that this action of fishes is a real yawn, and serves the true physiological purpose of a yawn, *i.e.*, flushing the brain with blood during periods of sluggishness. The conditions conducive to yawning are a slight increase in the temperature of the water, and, I suppose, the accompanying diminution of oxygen."

A NEW KIND OF SENSE ORGAN.—As anatomical analysis becomes more and more minute there is a continual discovery of new intricacies. A good illustration is to be found in an investigation which Dr. K. W. Dammermann has recently been engaged in, concerning the saccus vasculosus, a dependence of the brain peculiar to fishes. It will be remembered that there is a remarkable downgrowth, or infundibulum, from the tween-brain or region of the optic thalami (the part of the brain that also gives origin to the pineal body as a dorsal upgrowth). This infundibulum bears the very interesting pituitary body, but it also gives off a posterior diverticulum called the saccus vasculosus. In many fishes this extends backwards and lies, along with the pituitary body, in a pit of the skull called the sella turcica. It has been usually regarded as a glandular structure, but Dammermann has proved up to the hilt, what a few have suspected, that it is a sensory organ with somewhat striking sense-cells. In an ingenious argument he suggests that it may enable the fish to test the degree of oxygenation in the water, and thus to seek out the depth physiologically most comfortable. He proposes to call it a "Benthic" or Depth-Organ.

EVOLUTION OF REPTILIAN ARMATURE.—Georg Stehli has been studying the development of scales (in the wide sense) in various reptiles, and comparing recent with extinct forms. He is strongly of the view, also held by Hase and Otto, that the scales had primitively a segmental arrangement, and that each horny scale belonged primitively to an underlying bony scale. His theory is that the evolution of reptilian armour has passed through four stages. First, there was the primitive stage (which must, of course, have had a long evolution behind it) of strictly segmental arrangement of horny scales with bony scales beneath them. In some cases doubling gave rise to two rings of scales for each segment. Secondly, the bony scale broke up into a mosaic of little plates, as seen to-day in Scincoid lizards. Thirdly, the bony scale disappeared. Fourthly, the horny scales multiplied and lost their segmental arrangement.

A QUAINT STRUCTURAL ANALOGY.—One might spend a pleasant life-time in admiring organic adaptations. One of the last we have read about concerns the "snow-shoes" of the North-American ruffed grouse (*Bonasa umbellata*). According to Dr. Austin Hobart Clark, these "snow-shoes" develop in winter as two rows of "scutes" on each side of each toe, and they increase the area of the foot by as much again. Thus the bird treads safely on the lightly-compacted snow. It might be interesting to test experimentally whether the stimulus of wet feet at some other season than winter would induce the extra integumentary growth. Dr. Clark points out that a figure of the ruffed grouse's toe is very much the same as a figure of the arm of some of the Crinoids from deeper waters. Two rows of supplementary plates occur on each side of the median row, and the meaning of the adaptation is to increase the receptive surface on which the shower of minute dead organisms is caught. Convergent adaptation in two creatures almost literally as far as the poles apart!

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HAD CETACEANS A TWOFOLD ORIGIN?—It has been repeatedly suggested that the toothed whales are not very nearly related to the baleen whales, and Professor Kükenthal, in particular, has argued in support of a "diphyletic origin." Dr. Stefan Sterling, a worker in Kükenthal's Institute, has recently gone carefully into the musculature of the fore-limb, and finds that in respect to this the toothed whales and baleen whales are not very closely related. Their resemblance is one of convergence; that is to say, the flippers are independent adaptations to similar conditions. The toothed whales diverge further from the typical Mammal and must have had an earlier origin than the baleen whales. Thus anatomy illumines evolution. It is interesting to note that the flipper type of limb must have been evolved several times independently,—in Ichthyosaurs, in post-Triassic Plesiosaurs, in Cetacea (twice ?), in Sirenia, and in Pinnipedia.

REVIEWS.

AËRONAUTICS.

The Problem of Flight.—By HERBERT CHATLEY, B.Sc. 131 pages. 60 illustrations. 9-in.×6-in.

(Charles Griffin & Co. Price 10/6 net.)

This book, which bears the somewhat ambitious title of a "Textbook of Aërial Engineering," is not one which it is easy to review. The first edition was written some months before Farman, in January, 1908, succeeded in making the first circular kilometre flight in Europe. Owing to the author's absence in China, the present edition is admittedly not up to date, although numerous alterations and additions have been made to the text, and some of the original rather crude illustrations have now been replaced by more accurate photographic reproductions of various aëroplanes.

There is, however, no mention of the well-known Farman or Blériot machines, nor does the victorious Gnome engine receive any mention, and none of the recent work of the English constructors is described.

On the other hand this edition is not much blemished by misprints, though there are a few minor errors, such as on page 48b "Driwiski" for "Drzewiecki," and "Voison" for "Voisin."

Chapter I. deals with general considerations; Chapter II. with essential principles. In Chapter III. when discussing propellers, the author states (in effect) that the total projected blade area should approach very nearly to the disc area, provided the blades are not sufficiently near to cause interference; this does not seem to be very conclusive.

In Chapter IV. three methods of starting aëroplanes are given, but no reference is made to the Wright Bros.' pylon and falling weight device.

Chapter V. on "Ornithopters," is good, but does not command much interest at the present time; the author seems to have a particular penchant for the Helicopter, and devotes a good deal of space to this type throughout the book.

In Chapter VII. on "Form and Fittings of Aërial Vessels," the author states that "corrugated aluminium for helices and aëroplanes has been found to be very efficient," though it has not been used by any successful machine at the present date.

Some of the appendices are interesting, and are perhaps the most valuable portion of this book. In appendix H. the author discusses landing problems, but apparently has some idea that the aëroplane always meets the ground at its gliding angle; the operation of the "vol plané" does not seem known to him.

The bibliography at the end is not at all complete, nor is the list of aëronautical societies and clubs up to date. On the whole, however, the book gives plenty of food for thought, but the author endeavours to cover too much ground, and has a fatal tendency to indulge in mathematical jerry-building; edifices of most elaborate formulae are piled up on (in many cases) extremely slender foundations, and, as a result, are naturally neither of a permanent nor useful character.

There is no doubt that Mr. Chatley is an able mathematician, and if he will only alloy his theories with a greater number of practical facts, he may then succeed in producing something of value to the aëronautical engineer.

CHEMISTRY.

Spark Spectra of the Metals.—By C. E. GISSING, F.R.G.S. 21+vii. pages. 10 plates. 11¼-in.×8¾-in.

(London: Baillière. Price 7/6 net.)

The method of spectrum analysis is now so widely used to ascertain the composition of unknown bodies that this book of Admiral Gissing, which embodies an enormous amount of work, should be welcomed in many directions. It gives a brief description of the prism spectroscope and of the methods of obtaining spark spectra and recording them by photography, but its chief value will be as a work of reference. For since it gives photographic enlargements of the spectra of fifty different metals, alloys and gases, it will be a simple matter to ascertain, by comparison of the spectra and measurement of the wave lengths of the lines, the constituents of any mineral or mineral ore under examination. The photographs are excellently reproduced and notes are given to call attention to the most characteristic lines in each case.

Cambridge County Geographies—Fifeshire.—By E. S. VALENTINE, M.A. 187 pages. 64 illustrations. 4 Maps. 7⅜-in.×5½-in.

(Cambridge University Press. Price 1/6 net.)

The Scottish series of Cambridge County Geographies, so admirably begun with the volume on Lanarkshire, is well continued in the little book under review. By virtue of its position, the ancient kingdom of Fife—a peninsula jutting into the North Sea between the Firths of Tay and Forth, and separated from the rest of Scotland by the Ochil Hills, lends itself specially to treatment as a geographical unit. The unique geological phenomena found along its shores, its ancient history, its abundant mineral resources, and last, but not least, its claim to possess the Mecca of golfers, give Fifeshire special prominence amongst Scottish counties. Whilst largely an agricultural county, weaving, fishing, and mining particularly, employ a large proportion of its inhabitants. Dunfermline is the chief seat of table-linen manufacture in the world, and Kirkcaldy is almost equally famous for floorcloth and linoleum. Coal-mining has so progressed of late years that Fifeshire, from the third in 1899, had sprung to the first place among Scottish counties in 1906, in the quantity of coal shipped from its ports. In style, get-up and readability this book upholds the high character of this series; and Mr. Valentine has worthily maintained the standard set up by the initial volume on Lanarkshire.

An Elementary Treatise on Co-ordinate Geometry of Three Dimensions.—By R. J. T. BELL. 355 pages. 9-in.×6-in.

(Macmillan & Co. Price 10/- net.)

The author is Lecturer in Mathematics at Glasgow University, and has embodied in this book the course of his lectures in solid geometry. After preliminary matter the book deals chiefly with the Conicoids, but contains also chapters on Ruled Surfaces, Curvature, and Geodesics. It has copious

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examples, and might therefore be used to supplement a course of lectures; but we do not think a student would find it an easy introduction to the subject. The author has not the qualities of a good guide; he neither turns round to survey the ground already covered, nor stops to point out the path by which the climb is to be continued. The different subjects are not made complete in themselves, nor is the relative importance of different theorems or methods suggested. For instance, the Ellipsoid is introduced on page 83, but instead of being treated with proper respect, the form of its surface is dismissed with a reference to an example in small print on page 9. The book is well printed, but we are disappointed at the paucity of illustrations which, with geometrical methods, might be used to reinforce the analytical reasoning which the author alone allows; the chapters on the sphere and cone contain no figures at all, and a student will find no suggestions for drawing a sphere or representing points on its surface.

GEOLOGY.

The Witham and the Ancaster Gap, a Study of River Action.—By F. M. BURTON, F.G.S., F.L.S. 31 pages. 4½-in.×7-in.
(London:—A. Brown & Sons. 1/- net.)

The Winding Course of the River Wye.—By T. S. ELLIS. 10 pages. 5½-in.×8½-in.
(Gloucester:—John Bellows. 1/- net.)

In Mr. Burton's interesting booklet the theory of river origin we owe to the genius of Professor W. M. Davis is applied with signal success to the origin and history of the Witham and adjacent rivers, as it was also applied in the author's earlier brochure on the River Trent. The Witham is a remarkable river, which, rising near Oakham, first flows northward past Grantham to Lincoln, and then makes an abrupt turn to the south-east, entering the Wash near Boston. Excluding the very recent lower portion from Lincoln to Boston, Mr. Burton divides the river into three parts,—a tributary stream from its source to Grantham; a relic of an original transverse river (supposed to be the primeval Devon) from Grantham to Barkston; and again a tributary stream from Barkston to Lincoln. The original stream, the Devon, flowing east, cut out the Ancaster Gap, after which it was captured by the Trent, bringing the modern Witham into existence. There were several minor vicissitudes, well worked out by the author, before the Witham assumed its actual present course. The pamphlet would have been easier reading if a map illustrating the history of the river system had been included. Mr. Ellis, however, will have nothing of Professor Davis and consequent, subsequent or obsequent streams. His theory of river origin seems to be that of the evolution of principal channels out of a network of streams occasioned by the original irregularities of a land-surface newly arisen from the sea. He finds illustrations of the process in the water-channels on a gravelled or macadamized slope. The sinuosities of the Wye, for instance, are regarded as relics of an original network of channels. Mr. Ellis rejects the principle of stream capture, on the ground that he is unable to conceive of a stream working headwards and thus extending its valley backwards. He finds special difficulty in the case of valleys with low flat divides between streams falling in opposite directions, and believes that these valleys have always been excavated by the continuous flow of a body of water in one direction. Whilst some of these valleys may have been cut in this way as a stage in the development of a river system, the divides may have been smoothed by glaciers or by glacial lake overflows; and it must be remembered that low flat divides are characteristic of mature and ancient topographies. The paper is illustrated by a map of the Severn-Wye river system.

PHOTOGRAPHY.

Photography in Colours.—By GEORGE LINDSAY JOHNSON, M.A., M.D., B.S., F.R.C.S. 143 pages, with 8 plates in colour. 7¼-in.×5-in.
(Ward & Co. Price 3/-.)

The author states that he has separated Colour Photography from Photographic Optics when revising his work on the latter subject, and we cannot but feel that the separation is an advantage; there was, indeed, no reason for ever including two such distinct subjects within the covers of one text-book.

The present volume is, on the whole, a considerable advance on the treatment of the subject in the earlier work; the author has collected together the information which has been published by other workers, and has appended his own opinions to their conclusions.

This method occasionally leads to remarkable results, as when a solution of "Xyline red" is stated to be a nearly pure blue in colour; but, on the whole, the book is free from serious mistakes. On the screen plate processes of colour photography the book is very complete, but the short chapter on other processes is practically useless; it is far too scrappy and brief in its treatment. Incidentally we do not think that F. E. Ives ever claimed to have discovered "the principle of three colours being used to reproduce all colours." Ives invariably claims that the originator of the true theory of colour photography was Clerk Maxwell. We note with regret that the author prints his spectrum diagrams with the red to the left.

NOTICES.

WEBSTER'S NEW INTERNATIONAL DICTIONARY.—We have before us the details of the new dictionary which Messrs. Bell & Sons are publishing. As a matter of fact it is really a new work, for there are four hundred thousand references as against one hundred and seventy thousand in the previous dictionary which bore the same name. Very special attention has been given to the many new words which science has introduced into our modern vocabulary. Although there are two thousand seven hundred pages, and six thousand illustrations, the whole of these are contained in one volume, which is issued at a reasonable price. The dictionary is likely to meet the requirements of many of our readers, who can obtain all particulars on filling up and sending in the special coupon to be found on page iii of this issue.

CATALOGUES.—Among the many catalogues which we have received is one of lantern slides sent by Messrs. Flatters and Garnett, and we would call special attention to the photographs illustrating British Plant Associations, by Mr. W. B. Crump, whose ecological work is well known. Of special scientific interest also are the photomicrographs by Mr. W. T. Haydon, illustrating the reproduction and development of *Pinus sylvestris*.

As usual, the classified list of second-hand instruments which Mr. C. Baker has for sale or hire, is useful and exhaustive, seeing that it runs to eighty-two pages.

From Messrs. R. & J. Beck, Ltd., comes a special new catalogue of physical apparatus. Among some of the more important pieces are optical benches for the testing of photographic lenses as well as those which are used for spectacles. There are also some glass troughs of useful and various shapes which can be adapted to many purposes.

A MICROSCOPIC EXHIBITION.—Messrs. Watson and Sons, Ltd., 313, High Holborn, have sent us particulars of an Exhibition of Microscopic Objects which they are holding to enable microscopists to see for themselves the great diversity of objects which they offer.

In order that the whole of the contents of their cabinets may be easily examined, different subjects are set out week by week so as to be readily glanced at and subsequently examined microscopically.

Two of these Exhibitions have already been held and the current one from the 30th of January to the 8th of February, is of Botanical Subjects, Fungi, Algae and so on.

Future dates and subjects are:—

February 13th to 22nd, Geological and Entomological Specimens, Objects for Polariscope.

February 22nd to March 8th, Mounted Pond Life, Marine and Zoölogical Specimens.

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